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THE SCIENCE AND ART

OF

SURGERY.

" *They be the best* Chirurgeons *which being learned incline to the traditions of experience, or being empirics incline to the methods of learning.*"

BACON *on Learning.*

THE

SCIENCE AND ART

OF

SURGERY.

BEING

A TREATISE ON SURGICAL INJURIES, DISEASES, AND OPERATIONS.

BY

JOHN ERIC ERICHSEN,

SENIOR SURGEON TO UNIVERSITY COLLEGE HOSPITAL, AND HOLME PROFESSOR OF CLINICAL SURGERY IN UNIVERSITY COLLEGE, LONDON.

FROM THE FIFTH
ENLARGED AND CAREFULLY REVISED LONDON EDITION.

ILLUSTRATED WITH SIX HUNDRED AND THIRTY ENGRAVINGS ON WOOD.

WITH ADDITIONS,

BY

JOHN ASHHURST, Jr., A. M., M. D.,

VICE-PRESIDENT OF THE PHILADELPHIA PATHOLOGICAL SOCIETY, FELLOW OF THE COLLEGE OF PHYSICIANS, MEMBER OF THE ACADEMY OF NATURAL SCIENCES, SURGEON TO THE EPISCOPAL HOSPITAL, LATE EXECUTIVE OFFICER TO THE CUYLER U. S. A. GENERAL HOSPITAL, ETC. ETC.

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PREFATORY NOTE.

In its present greatly enlarged form, this new edition of Erichsen's Surgery is confidently submitted to the profession in America, as fully sustaining the high reputation of its predecessors.

It is sufficiently comprehensive for all practical purposes, and is believed to be a thoroughly trustworthy text-book and volume of reference for both student and practitioner.

Notwithstanding the care with which the author has sought to embody in his work the latest results of surgical science, certain practical matters, some of which are of special interest to American surgeons, have not been adverted to. These the undersigned has endeavored to supply as briefly as possible. His additions will be found inclosed in brackets, and signed with the initial [A.]

JOHN ASHHURST, Jr.

2000 West DeLancey Place,
Philadelphia, *July*, 1869.

PREFACE

TO THE FIFTH EDITION.

THE favorable reception with which the first four editions of the "Science and Art of Surgery" have met in this country, on the Continent of Europe, and in America, has induced me to spare no exertion to render the Fifth Edition worthy of the continued confidence of the Profession as a Guide to the Practitioner, and as a Text-Book for the Student in Surgery.

With this view the whole Work has been remodelled. Many of the Wood-cuts have been re-drawn, and nearly one hundred new ones added. Some Chapters have been in a great measure re-written, and much new matter has been added beyond the mere general enlargement of the Work. The additions thus made have not been confined to any one particular part, but have been widely and generally distributed through the various subjects of which the Work treats. I have endeavored to embody in them an account of the more important recent advances in the Science of Surgery, and the results of my own more extended experience in the Practice of its Art.

Surgery is that Department of the Healing Art which comprises the consideration of—

1. The Injuries—from whatever cause arising—to which the human frame is liable.

2. Malformations and Deformities, Congenital and Acquired.

3. All External Diseases; and all those Diseases that specially or primarily affect the Organs of Sense, of Locomotion, and of Reproduction.

4. All those Diseases that require Manual, Mechanical or Operative Means for their cure or relief; and the nature and application of such means.

The general arrangement adopted in previous Editions of this Work has been preserved in the present one. The Book is divided into three parts. The First Division, under the head of FIRST PRINCIPLES, contains general observations on Operative Surgery, and more especially on Amputations; together with a condensed view of the Nature and Treatment of Inflammation and its Special Forms. The Second Division comprises the consideration of SURGICAL INJURIES; and the Third that of SURGICAL DISEASES.

In considering both Injuries and Diseases, it has appeared to me to be more consistent with a natural arrangement to treat, 1st, of those common to all parts of the Body, as Wounds, Abscesses, Ulcers, &c.; 2d, of the Injuries and

Diseases of Special Tissues, as of the Osseous Tissue—Fractures and Necrosis; of the Vascular Tissue—Wounds of Bloodvessels and Aneurisms; and, 3d, of the Injuries and Diseases of Regions.

The more Special Operations I have considered as part of the Treatment of the different Injuries and Diseases for which they are required; a plan which I consider to be more practically useful than to describe them apart as a separate subject.

Throughout the Work, it has been my object to place before the practitioner and student the Science and Art of Surgery, not as consisting merely in the observation of such Diseases, Injuries, and Malformations as belong to the classes mentioned above, or in the dexterous application of manual or operative means for their relief; but as demanding an exercise of general Medical knowledge, and a thorough acquaintance with all those conditions, whether intrinsic to the patient or surrounding him, that favor or prevent his restoration. The remarks in the commencing paragraphs of the first Chapter will, it is trusted, sufficiently indicate to the student what is required of him in this respect, in order that he may become a successful practitioner.

In every instance, I have endeavored to give as plain and full a description of Symptoms, Pathology, Diagnosis, and Treatment, as the importance of each demands, and the present state of our knowledge permits. With regard to Diagnosis, I may specially remark that, as accuracy in this branch is an all-important requisite for success in Treatment, I have, in each case, not merely described the signs and symptoms by which the injury or disease under consideration may be recognized, but have been careful—even at the risk of repetition—to point out the several conditions with which it may be confounded, and the means of distinguishing it from each of them.

In order to facilitate reference to the very varied contents of the Work, the Table of Contents has been carefully arranged; and the Index, which has been rendered partly etymological, has been extended.

The "Science and Art of Surgery" has hitherto appeared in one Volume; but the progressively increasing size of the Work in each successive Edition has rendered the continuance of this arrangement inexpedient. Accordingly, in the present Edition it has been divided into two Volumes; and it is hoped that it will thus have been made more convenient for the purposes of study and of reference.[1]

The absence of a detailed description of the more important Operations that are practised on the Eye and its Appendages has long been felt as a want by many readers of former Editions of this Work, and my attention has repeatedly been called to it. As Ophthalmology has, from its extent and importance, become almost a distinct branch of the Profession, and has to a great extent been removed from the practice of the General Surgeon, I felt that I should best consult the interests of the student and practitioner by placing the Chapter that could be devoted to this important subject in the hands of a gentleman able to do full justice to it, rather than by attempting to undertake it myself. I accordingly requested my colleague, Mr. Streatfeild, one of the Ophthalmic Surgeons

[1] [By the use of a greatly enlarged page the two volumes of the English Edition have been printed in one, without omission or curtailment.—A.]

to University College Hospital, and Surgeon to the Royal Ophthalmic Hospital, to take charge of this portion of the Work. This he kindly consented to do; and Chapter LVI. has accordingly been written by him, in a way to give in a condensed form, and in accordance with the general scope of the Work, an account of the Ophthalmoscope, of some of the more important Diseases of the Eye and its Appendages, and more especially of the Operations for their relief and cure. The manner in which Mr. Streatfeild has executed the task he has undertaken is such as, I feel sure, will add greatly to the utility of the Work.

To my colleague, Mr. Berkeley Hill, I am indebted for much valuable assistance in re-arranging the Chapter on Syphilis.

To my friend and former pupil, Mr. Alexander Bruce, I am under great obligations for the assistance which he has rendered me generally in the various Chapters relating to General Surgical Diseases, especially those on Pyæmia, Scrofula, and Tumors. To Mr. Bruce also I am indebted for several of the Drawings from which the Cuts have been taken that illustrate this and other portions of the Work.

To Dr. A. Henry I am under very deep obligations for the very able assistance which he has given me in the literary part of the Work, and for the care and attention he has bestowed on it in its passage through the press.

To many of my colleagues and former pupils I am indebted for assistance in the preparation of this Edition. To Drs. Wilson Fox and Sydney Ringer, to Messrs. C. Heath, Beck, Allchin, and Eck, I would more especially express my obligations.

For any clerical errors in this Work, I must beg the reader's indulgence. It has been prepared in the midst of the harassing and onerous duties that devolve upon a Hospital Surgeon, a Teacher of Surgery, and a Private Practitioner in this Metropolis, which are but little favorable to literary pursuits.

JOHN ERIC ERICHSEN.

6, Cavendish Place, London, W.

December, 1868.

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CORRIGENDA.

Page 46, line 60, *for* inhalers, *read* inhaler.
" 686, " 36, *for* 181, *read* 728.
" 1086, " 19, *for* 1859, *read* 1858.
" 1086, " 24, *for* the year previous to, *read* before.

THE

SCIENCE AND ART OF SURGERY.

DIVISION FIRST.

FIRST PRINCIPLES.

CHAPTER I.

GENERAL CONSIDERATIONS ON OPERATIONS.

By a Surgical Operation is meant a Manual or Mechanical Process undertaken by the Surgeon for the remedy of Deformity, congenital or acquired, or for the cure or relief of a patient suffering from the effects of Injury or Disease, that are incurable by constitutional or ordinary local treatment, or in which such treatment would be too slow in effecting the desired result.

A *Surgical Operation* may be rendered necessary by the following conditions:—

1. For *Remedying or Removing Congenital Defects and Malformations:* as Hare-lip, Club-foot, or Supernumerary Fingers or Toes.

2. For *Remedying Acquired Defects and Deformities:* as in the Closure of Fistulæ, the Restoration of Lost Parts, and the Correction of Distortions of the Limbs.

3. For the *Removal of Foreign Substances* from the Body: as in the Extraction of a Bullet or a Calculus.

4. For the *Repair of the Effects of Injuries:* as in the treatment of certain Fractures and Dislocations.

5. For the *Removal of Parts* that have been so disorganized by the effects of *Injury* that their vitality is lost, or that their continued connection with the rest of the body would be a source of danger: as in Amputation for Frost-bite or Mangled Limbs.

6. For the *Removal of Diseased Structures* that interfere with the utility of an organ or part: as in the Extraction of a Cataract.

7. For the *Removal of Diseased Structures* that seriously inconvenience the patient or that remotely threaten life: as in the Extirpation of Tumors, Simple or Malignant.

8. For *Rescuing a Patient from Immediate and Inevitable Death:* as in Tying a Bleeding Artery, Opening the Windpipe in Laryngeal Obstructions, Relieving an Over-distended Bladder, or Dividing the Stricture in Strangulated Hernia.

Manual dexterity is necessarily of the first advantage in the performance of any operation, and the Surgeon should diligently endeavor to acquire the art of using his instruments with neatness, with rapidity, and with certainty. In many cases of minor moment, no other requisite is needed by the Surgeon than this. But it would, indeed, be a fatal error to suppose that, in the majority of cases requiring surgical interference, this is the only or indeed the chief requirement on the part of the operator. Manual dexterity must not be mistaken for surgical skill; and, desirable as it doubtless may be to be able to remove a limb, or to cut out a stone, in so many seconds—important, in a word, as it is to become a dexterous operator—it is of far greater importance to become a successful Surgeon. The object of every operation

is the removal of disease that either threatens life, or interferes with the comfort and utility of existence; and the more certainly a Surgeon can accomplish this object, the better will he do his duty to his patients, and the more successful will he be in his practice. Success, then, in the result of an operation, whether that result be the preservation of life or the removal of a source of discomfort, is the thing to aim at. To this, dexterity and rapidity in operating are in a high degree conducive; but there are various other considerations equally or still more necessary, the solution of which can only be afforded by an intimate general acquaintance with the Science of Surgery and of Medicine. The Diagnosis of the nature of the local disease, and of the extent of its connections, has to be made; lurking visceral affections must be detected and, if possible, removed. The Constitution of the patient must be prepared; the best time for the performance of the operation seized; and, after its completion, the general health must be attended to in such a way as shall best carry the patient through the difficulties he has to encounter, and any sequelæ or complications that arise must be met by, and must be subjected to, appropriate treatment. These as well as the simple performance of the operation, are the duties of the Surgeon; and on the manner in which they are performed, as much as, or even perhaps more than on the mere manual dexterity displayed in the operation itself, will the fate of the patient depend. It is well known that the result of operations differs much in the practice of different Surgeons of acknowledged dexterity; and this variation in the proportionate number of recoveries cannot be accounted for by any difference in the degree of manual skill displayed in the operation itself, but must rather be sought in the greater attention that is paid by some Surgeons to the constitutional treatment of their patients before and after the operation, and to their more perfect acquaintance with the general science and practice of surgery. Indeed, success in operative surgery depends greatly upon the selection of proper cases. The practice of operating in notoriously hopeless cases with the view of giving the patient what is called a last chance, is much to be deprecated, and should never be followed. It is by operating in such circumstances, especially in cancerous diseases, that much discredit has resulted to surgery; for in a great number of instances the patient's death is hastened by the procedure, which, instead of giving him a last chance, only causes him to be dispatched sooner than would otherwise have happened. It may truly be said that a great surgical operation, in its conception, its performance, and its completion, tests the operator's medical knowledge as much and in as varied a manner as it taxes his manual skill; and that, taken as a whole, it is the highest development of the medical art.

Conditions Influencing the Success of Operations.—The circumstances that mainly influence the result of an operation, so far as the recovery of the patient is concerned, may be arranged under three heads: 1. Those that are connected with the *State of the Patient's General Health* at the time of its performance; 2. The *Hygienic Conditions* by which he is surrounded after it is done; and 3. The *Special Dangers* connected with the operation itself.

1. The condition of a patient that principally determines the result of an operation is the *State of his General Health.* Indeed, success is influenced far more by the state of the patient's constitution than by the severity of an operation, or by the mechanical dexterity with which the Surgeon performs it. How often do we see a patient carried off by fatal disease supervening on some extremely trifling operation, which in itself ought in no way to endanger life (such as for the removal of a small encysted tumor), were it not that the patient's constitution was at the time of its performance in so unhealthy a state that the slightest exciting cause was sufficient to call into activity fatal disease? So, also, it is no uncommon circumstance to see one patient sink after the most dexterously performed operation for hernia, stone, the ligature of an artery, &c., owing to some morbid condition of the blood or of the system that disposes to low or diffuse inflammation; whilst another may possibly make the most remarkable and rapid recovery after he has been mutilated with but little skill. Independently of actual organic disease, there are certain conditions of the body with respect to the condition of the nervous system, the circulation, and the general physical state, that exercise an injurious influence. Thus, persons of an irritable and anxious mind do not bear operations so well as those of a more tranquil mental constitution Those also of a feeble and irritable habit of body, especially nervous and hysterical women, with little strength of circulation, cannot bear up against severe surgical procedures; being apt to become depressed and exhausted,

and to sink without rallying. Persons who are overloaded with fat are not good subjects for surgical operations. In them the circulation is usually feeble; the wound heals slowly, and is apt to become sloughy, and intercurrent disease of a low type often sets in. Short of actual structural disease of important organs, as the lungs, heart, or kidneys, I know no condition more unfavorable to success after operations than premature or excessive obesity.

An individual of a sound constitution, that has never been impaired by excesses of any kind, whose habits have been temperate and sober, whose diet has been sufficient and of good quality, whose mind has never been overstrained by the anxieties of business or the labors of a professional life, and whose existence has been spent in rural occupations and in the pure air of the country, is necessarily placed in a far more favorable position to bear the effects of any mutilation, whether it be the result of injury, or be inflicted by the surgeon's knife, than the man of active and unceasing business avocations or professional habits, whose nervous system is exhausted by his anxious labors; and far more so than the poor inhabitant of a large and densely peopled town, who has from earliest childhood inhaled an impure and fetid atmosphere, whose scanty diet has consisted of the refuse of the shops, or the semi-decomposed offal of the stalls, and whose nervous system has been irritated and at the same time exhausted in the daily struggle for a precarious livelihood, or overstimulated by habitual excesses in strong drinks, by which he has hoped to purchase temporary forgetfulness of the cares of life. Though individuals with such different antecedents be placed under exactly the same hygienic circumstances *after* the performance of an operation, yet the results will probably be very dissimilar, influenced as they must be by their past rather than by their present condition. In the one case, the inflammation resulting from the incision, and requisite for the cure of the wound, will not overstep the normal degree necessary for the healing process. In the other it may not attain to this, but, assuming a low and diffuse form, may terminate in some of those secondary affections which will presently be adverted to as occasioning death under unfavorable hygienic conditions.

Besides the general state of the patient's health, the *condition of important organs* must be taken into consideration. The state of the patient's *heart* should be carefully looked to before an operation is undertaken. Fatty degeneration of this organ, as indicated by its feeble action, by irregularity and want of power in the circulation, by breathlessness, and by a distinctly marked arcus senilis, should make the surgeon careful in undertaking any operation attended with much loss of blood or shock to the nervous system; though this need not be a bar to its performance, if the disease for which it is to be practised would otherwise be fatal. Disease of the *lungs*, of a phthisical character, when active or advanced, is incompatible with the success of an operation; but under certain circumstances, as will be explained when speaking of diseases of the joints and fistula in ano, an operation is justifiable and proper, even though the patient be consumptive. Perhaps the most serious constitutional affection, and the one that more than any other militates against the success of an operation, is a diseased state of the *kidneys*, with albuminuria or diabetes; in these conditions, the local inflammatory action that is set up is apt to run into a low, diffuse, and sloughing form, and this is especially the case in all operations about the genito-urinary organs.

The contamination of the patient's system by malignant disease must always prevent our operating, as a speedy return of the affection will most certainly take place. And, lastly, no operation, save of the most urgent necessity, and to rescue the patient from immediate death, as for the suppression of arterial hemorrhage, should ever be performed whilst he is laboring under pyæmia, septæmia, erysipelas, phlebitis, or any diffuse inflammation; and even during the epidemic prevalence of these affections, operations that are not of immediate necessity should be postponed until a more favorable season. Operations in very old people, if severe, and attended by much shock to the system, are commonly fatal; amputations in individuals above the age of seventy are very rarely successful.

2. The result of an operation, though greatly dependent on the state of the patient's constitution at the time of its performance, is also materially influenced by the *hygienic conditions to which he is afterwards subjected.* The conditions which chiefly militate against the success of an operation, are bad or insufficient diet, the exposure of the patient to the influence of contagious miasmata, and more

particularly the overcrowding of the sick and wounded, which produces an impure state of the atmosphere, productive of the most fatal consequences.

The proper regulation of the patient's *diet* before and after an operation is of great consequence. On this point it is impossible to lay down any very definite rule, as much depends not only on the patient's previous habits of life, but on the nature of the operation itself; and, as this subject will be discussed at the end of the chapter, it need not detain us here. It is not, however, often that in civil practice the insufficient quantity or the bad quality of the patient's food, with which he is supplied *after* the performance, influences materially the result of an operation. But in military and naval practice the case is far different. The soldier or the sailor on active service is often exposed to serious injuries that necessitate the more important operations at a time when his constitutional powers have already been broken down by scurvy, dysentery, or some other similar affection, resulting not so much from the deficient quantity as from the unwholesome character of the food with which alone he can be supplied. And after the operation his only available nutriment may be of the coarsest character, possibly salted and imperfectly cooked. In such circumstances operation-wounds do not heal, or they assume a peculiar gangrenous character; or the patient sinks from ulceration of the intestinal mucous membrane. The mortality of operations becomes enormously increased; and there can be little doubt that thousands of deaths which have occurred in wars between the most civilized nations and the best appointed armies may be attributed to these causes.

The exposure of a patient after an operation to *contagious emanations* from other sick or wounded patients, may be attended by the most fatal consequences. Whenever it is practicable, every case of pyæmia, erysipelas, inflamed absorbents or veins, or hospital gangrene, should be rigorously excluded from the same ward or room in which other patients with operation-wounds happen to be lying; and, if possible, the same nurses, dressers, or surgeons should not be allowed to go from the infected to the healthy, nor should the same dressings or sponges be used for both. Every Hospital Surgeon must have had abundant occasion to deplore many deaths after operation, arising from preventable causes due to want of attention to these precautions.

[Fig. 1.

Ward carriage.]

[A very ingenious "ward carriage" has been devised by Dr. Thomas G. Morton, of Philadelphia; one of its most important features being an arrangement by which all wounds can be washed with a constant stream of pure water, thus dispensing altogether with the use of sponges, and of course so far obviating any risk of transferring morbid products from one case to another. This apparatus, with slight modifications, is now in daily use in the Pennsylvania, Philadelphia, and Episcopal Hospitals, and is about to be introduced into the Liverpool Northern Hospital. (*Pennsylvania Hospital Reports*, vol. ii. pp. 281–285.) A similar apparatus has been successfully used in the Military Hospitals of Dresden.—A.]

Perhaps there is no hygienic condition of greater importance, so far as the results of operations are concerned, than the avoidance of *overcrowding* of operation-cases or of injured persons in one ward or building; more particularly if the wounds be in a suppurating state. In these circumstances, the atmosphere becomes loaded with animal exhalations in a state of putrescence or fermentation. These are either absorbed by the lungs and skin, or the pulmonary and cutaneous surfaces are unable to set free their excreta in an atmosphere already surcharged; the blood becomes thereby vitiated, and low, diffuse, or erysipelatous inflammations of all kinds, with pyæmia, septæmia, or sloughing phagedæna, are the necessary consequences. In fact, these diseases may, if the term is allowable, be manufactured in any hospital or house, however clean and well situated, by the accumulation within it of too large

a number of patients suffering from suppurative fever. The two great conditions to be attended to in the prevention of overcrowding are: (1) Sufficient cubic space for each patient; and (2) An efficient system of ventilation. Both conditions are equally necessary. The *space* afforded to each patient in the surgical ward of an hospital, where patients with suppurating wounds are mixed with others suffering from such injuries as simple fractures unattended by breach of surface, should be at least 1500 cubic feet. If the proportion of simple cases be great, less than this may be safe; but if the majority of the patients have suppurating wounds, more space, as much even as 1800 cubic feet, should, if possible, be allowed. Whenever we have had an outbreak of the confirmed low surgical inflammations—of erysipelas, sloughing phagedæna, or pyæmia—in the wards at University College Hospital, it has been owing to the accidental and, perhaps, unavoidable accumulation of a large number of serious injuries or of operation-cases in one ward, so that the cubic space for patients became reduced materially below the figures above stated. Not only is *space* required, but *change of air*, by proper *ventilation*, is equally needful. For however large the cubic space for patients, the air, if not changed rapidly enough, soon becomes loaded with animal exhalations, and highly insalubrious. Hence care should be taken that a free current of pure air through the ward be maintained day and night. It is from want of this precaution during night especially that much mischief often results. The importance of maintaining efficient ventilation during night, and the little danger to be apprehended from the admission of cold night air, have been so forcibly pointed out by Miss Nightingale in her *Notes on Nursing*, and are now so universally admitted, that I need not do more than add the testimony of my experience to the truth of her observations. In cold weather, also, there is so great a disposition on the part of nurses and patients to shut up wards and rooms, that the air becomes close, oppressive, and contaminated; and hence it is that the erysipelatous and miasmatic diseases are so rife during winter and early spring. The "East Wind" is commonly accused of being the cause of these; and no doubt it is so, but only indirectly, by causing windows and doors to be shut, so as to exclude the cold that usually accompanies that wind, and thus rendering the atmosphere impure. It is impossible to over-estimate the importance of a free supply of pure air in lessening the mortality after operations, not only in hospitals, but equally in private dwellings. Hence the performance of operations in close and ill-ventilated rooms, or in houses situated in overcrowded, badly-drained neighborhoods, should, as far as possible, be avoided until the patient can be placed in more favorable hygienic conditions.

The mortality arising from inattention to these various hygienic conditions is not a necessity of the operation, but rises or falls according as the circumstances in which the patient is placed depart more or less widely from those conditions that are necessary to the maintenance of health. It is by the induction of pyæmia and of the erysipelatous inflammations, with fever of a low type, that the neglect of the hygienic conditions of operated patients destroys life. The prevalence of these diseases in a locality or an institution is the measure of, and in direct proportion to, the deteriorated constitutions of the inhabitants, and the breach of sanitary laws.

3. The *Special Conditions directly excited by the Operation itself* (though predisposed to by the circumstances that we have just been considering) and which commonly lead to a fatal result, of which they are the immediate occasion, are the following: Shock, Exhaustion, Hemorrhage, Gangrene, Tetanus, Internal Inflammation of an acute kind, Pyæmia, and the various Low, Diffuse, and Erysipelatous Inflammations. These causes of death are so various, and comprise so many distinct diseases, that I shall do little more here than mention them; referring the reader to the different Chapters in the Body of the Work, in which each is specially treated.

The *Shock of an Operation* may prove fatal in various ways: from the severity of the mutilation, as in a case of double amputation; from the nervous centres being implicated, as in the removal from the face of large tumors that have connections with the base of the skull; from fear, or from the state of nervous depression, into which the patient has previously fallen, causing him to feel the influence of an operation disproportionately to its severity. These various effects of shock have, however, been much lessened since anæsthetics have been generally administered in operative surgery. Anæsthesia, however, does not remove the physical impression produced on the system by a severe mutilation; hence the influence of a serious and prolonged operation is still manifested in the production of shock, of collapse, and

of slow recovery, even though the patient have suffered no actual pain. Certain operations appear to exercise a peculiar depressing effect on the nervous system, even though no pain be experienced. Thus, in castration, at the moment of the division of the spermatic cord, I have often observed the pulse to sink markedly, even though the patient have been fully anæsthetized. So much is this the case, that it is well at that moment to suspend the administration of the chloroform.

Exhaustion, without any tangible local or constitutional disease, is an occasional cause of death after severe operations; more particularly in delicate females, in feeble or debilitated subjects, or in those who have lost much blood.

Hemorrhage, if very copious, may destroy the patient by inducing syncope that may be immediately fatal; or by increasing the influence of the shock so that he cannot rally; or it may be followed by serious after-consequences, such as the supervention of hemorrhagic or irritative fever, and a disposition to the occurrence of low and erysipelatous inflammations. It is in these secondary and indirect effects that the great danger of excessive hemorrhage lies. Patients who have lost much blood make slow recoveries, often interrupted by intercurrent diseases; and not unfrequently die at the end of two or three weeks, from some asthenic visceral complication. In fact, it is in this way, rather than from its immediately dangerous consequences, that the loss of a large quantity of blood at an operation proves injurious to the patient. When hemorrhage occurs a few hours, or a day or two, after an operation, it usually proceeds from imperfect ligature of the vessels, or from arteries bleeding after the setting-in of reaction, which had not furnished blood whilst the patient was under the influence of the shock of operation. On recovery from chloroform also, it not unfrequently happens that arteries begin to spout, which yielded little or no blood whilst the patient was in a state of anæsthesia. In these circumstances, hemorrhage is of far less moment, and less frequently fatal, than when it occurs at a later period, in consequence of some morbid condition of the wound or system, and usually in association with a typhoid state, by which the proper formation of plastic matter is interfered with. During the performance of an operation, hemorrhage should, as much as possible, be prevented; the operation itself is a cause of depression, and any great loss of blood not only seriously aggravates this, but disposes to the after-occurrence of pyæmia and low inflammations.

The *Performance of an Operation during the Existence of any Acute Inflammation*, as of a joint, for instance, is always attended by great danger: more especially, if the disease be an inflammation of a low form, as phlebitis or erysipelas. So great is the danger of performing any, even the most trifling operations, in cases of this kind, that they never should be undertaken, except such—the ligature of a bleeding vessel for instance—as may be imperatively required for the immediate preservation of life. The danger in these cases is from the supervention of pyæmia. This appears to be occasioned by the blood, in such cases, being loaded with a quantity of effete materials, which run into a state of suppurative disorganization under the influence of the new inflammatory action set up by the operation.

Gangrene is not a common cause of death after operations. In some cases of amputation, however, it may occur in the stump; after the operation for strangulated hernia, in consequence of the constriction of the gut; or in any wound, in its contagious form of sloughing phagedæna.

Tetanus but rarely occasions death after operations in this country. When it does occur, it is more frequently after the lesser than after the greater operations that it develops itself.

Internal Inflammations of an acute and active character may carry off the patient after an operation, in two ways. Inflammation of this kind may have existed antecedently to the operation, being the disease for which it is performed; and, being unchecked by the operation, may continue its course and destroy life. Thus, when a child dies after tracheotomy for croup, death is not in general occasioned by the operation, but by the extension of the disease for which it has been performed. Or the inflammation may be the necessary and direct consequence of the operation; as when peritonitis occurs after the operation for strangulated hernia, or arachnitis after the skull has been trephined. But it is not by the action of any of these direct results that an operation usually proves fatal. In the great majority of instances, death is occasioned in a more indirect manner by the development of pyæmia, or of some of those low and erysipelatous inflammations which are allied to it, and to which a neglect of hygienic laws acts as a powerful predisposing cause.

Pyæmia is certainly the most frequent cause of death after operations, more particularly in large towns. It is especially and directly predisposed to by the neglect of hygienic laws by the patient previously to the operation, and by the unfavorable sanitary conditions by which he may be surrounded after its performance. Closely allied to pyæmia, frequently co-existing with it, having the same predisposing causes, and associated with febrile disturbance of an asthenic type, are the various *low and diffuse inflammations*, whether assuming the form of erysipelas, of phlebitis, or of inflammation of the absorbents, which are the dread of surgeons and the scourge of hospitals. It is to pyæmia, and to these various allied erysipelatous and low inflammations, with their attendant asthenic constitutional disturbance, that at least three-fourths of the deaths after operations are due. It is in the production of these diseases that an impure blood, loaded with effete materials retained through habitual disregard of the ordinary rules of health or through defective elimination by the kidneys and skin, acts as a potent predisposing cause, requiring but some injury or wound to call into activity a most dangerous amount of local inflammation and of constitutional disturbance. In these circumstances, it is not the extent or size of the wound that determines the dangerous results. The mere fact of a breach of surface, however trivial, is sufficient to excite these morbid processes, the materials for which have been previously stored up in the system. In such conditions of the system, the amputation of a toe may be as fatal as that of the thigh, or the removal of a small scalp-atheroma as the ablation of the breast; the only additional danger essentially connected with the greater operations being the increased risk from shock and hemorrhage.

Diphtheritic Inflammation may develop in a wound with or without concomitant throat-affection. It may be developed by direct contagion, or under the influence of those local epidemics or constitutional influences that cause diphtheria to appear in the fauces. When a wound becomes affected in this way, the edges and the integument for some little distance around are swollen, brawny, and of a deep red color; the surface of the wound is covered with a grayish-white exudation which cannot be cleaned off; the skin immediately contiguous to the wound also becomes besmeared with tenacious creamy-looking exudation matter; and febrile symptoms of a low type develop themselves.

Preparation for Operation.—The Surgeon, being convinced of the necessity of having recourse to operation, should fully and unreservedly lay before his patient *the state of the case*, and, if necessary, give *the reasons that render an operation imperative*, in order to obtain his consent and that of his family. In the event of the patient refusing to submit, what course should the surgeon pursue? In this he must be guided partly by the nature of the proposed operation; and partly by the state of the patient, and his capability of forming a correct judgment of his case. If the operation be one of expediency, merely for the relief of an infirmity or the removal of an ailment which does not directly jeopardize life, most certainly no surgeon would think of undertaking it without the full consent of his patient. If, on the other hand, it be an operation that is imperatively necessary for the preservation of life, in which the delay of a few minutes or hours may be fatal to the patient, as in the case of the proposed ligature of a bleeding artery, or the relief of a strangulated hernia, and where the patient, not being aware of, or capable of being made to understand, the necessity for immediate action, is unwilling to assent to the proposal, the surgeon will truly be placed in a dilemma of anxious responsibility; between allowing the patient to fall a sacrifice to his ignorance or timidity, and attempting, perhaps unsuccessfully, to rescue him from inevitable death against his own consent. I believe the proper course for the surgeon to pursue under such circumstances, is to judge for the patient in a matter on which he is clearly unable to form an opinion, and to compel him, so far as practicable, to submit to the necessary steps for the preservation of his life, or to put him under chloroform, and, when he is anæsthetized, to perform any operation that may be necessary. In the event of the patient being insensible, as after an injury of the head, the surgeon must necessarily take upon himself to act as the case requires. Children cannot be considered capable of giving an opinion as to the propriety of an operation; the consent of the parents is here necessary, and quite sufficient; and, in their absence, the case being an urgent one, the surgeon must stand *in loco parentis*, and take all responsibility upon himself.

These points then having been determined, the patient should, if possible, be

Prepared for the Operation. In a great number of cases requiring operation, as in strangulated hernia, bad compound fracture, &c., no time is allowed for preparation, but the surgeon must at once submit the patient to the knife, whatever the state of his constitution may be. But in the more chronic cases, time is given for improving the constitution. This preparation must not consist in any routine system of purging and starving, which is ill calculated to support the constitution against the call that will be made upon its powers; nor, on the other hand, in a tonic or stimulating regimen, which may produce fever and irritate the constitution; but in adapting our means to the condition of the patient and the nature of the operation to be performed. The tendency to erysipelas, pyæmia, and low and diffuse inflammations generally, is materially lessened by supporting the patient's strength, by means of a nutritious diet, previously to the performance of the operation. Indeed, in many of the more severe cases of compound fracture and disease of the joints, it is only by the use of a nutritious diet, and by the administration of tonics, quinine, or iron, and stimulants, often in large quantities, that the patient can be brought into a condition to bear the shock and consequent depression of the operation. This is more particularly the case with hospital patients of bad constitution, who have met with serious accidents, attended by much suppuration and irritative fever. In the more chronic cases, the time should be seized for the operation when the secretions are free, the tongue clean, and the action of the skin and kidneys in a healthy state; and, above all, the mind should be kept tranquil and hopeful, being allowed to dwell as little as possible upon the impending event. In many operations, as those on the rectum and urinary organs, or in those of a plastic character, special modes of preparation are required, which will be discussed when we come to treat of the operations in detail.

The *Immediate Preparations* for the operation should always be superintended by the surgeon himself. He must see that the table is solid, and of a convenient height, well covered with blankets, and provided with pillows; and that the light of the room is good. There must be a sufficient supply of sponges and of basins, with hot and cold water; and, if the operation be likely to be attended by much hemorrhage, a tray filled with sand or saw-dust should be provided, in order to catch the blood. The surgeon must then look over his instruments, comparing them, if the operation be complicated, with a list previously made out; he must see that they are arranged in the order in which they are wanted, and properly covered with a towel. Much of the successful performance of an operation depends on the attention and steadiness of the assistants. Of these there should be enough, but not too many. In all capital operations three or four will be required; one for the administration of the anæsthetic, another to command the artery, a third immediately to assist the surgeon, and the fourth to hand sponges, instruments, &c. The duties of the assistants should be performed in silence, and each man must carefully attend to his own business, and not neglect this, as is too often done, in his anxiety to crane over and see what the surgeon is about. There should be no unnecessary talking when once the patient is on the table; the surgeon's directions ought to be conveyed by a brief word or two, by a look, or by a sign with the hand.

The surgeon himself must always feel the heavy responsibility that hangs over him during the performance of a great operation—"at that moment when," as Dr. Grant has elegantly said, "Death everywhere surrounds his knife as he is endeavoring to convey all his knowledge to its point." But having carefully considered each successive step of the operation, provided for every emergency that can by any possibility arise in the course of it, and trusting in Him, from whom all knowledge is derived, to strengthen his judgment and guide his hand aright, he will proceed to the performance of his duty with self-reliance, and in the full confidence of being able to effect all that art can accomplish.

Employment of Anæsthetics.—It is reasonable to believe that the prevention of pain in surgical operations has been an object of solicitude to surgeon as well as to patient from the earliest ages: and there can be little doubt that narcotics of various kinds have at different times been employed with this view. But the effect of these was so uncertain—their after consequences perhaps so injurious—that no permanent reliance was placed upon them. The first endeavor to induce anæsthesia by the inhalation of vapors is stated to have been made in the thirteenth century by Theodoric, who recommended that a "Spongia Somnifera," impregnated with spirituous extracts of various narcotic substances, should be held to the nostrils till sleep was

induced; and that after the operation the patient should be roused by the use of vinegar or fenugreek. It was not, however, till the commencement of this century that any serious attempts were made in this direction. The discovery of the remarkable properties exercised on the nervous system by the inhalation of nitrous oxide then led Sir Humphry Davy and others to entertain hopes that it might be used as a means of relieving pain during surgical operations. Experiments were made with the gas with this view, but they did not prove altogether satisfactory, and it was abandoned, except as a means of amusement.

It is needless to do more than allude to such means as the compression of the nerves of the limb, as recommended by Moore—the employment of excessive venesection, as adopted by Wardrop—or the production of insensibility by mesmerism. These means of inducing anæsthesia were either inefficient, dangerous, or chimerical.

It was not until 1844 that a serious attempt was again made to introduce insensibility during operations by inhalation: and to the Americans is undoubtedly due the honor of having established the practice of anæsthesia in surgery. In that year Horace Wells, a dentist of Hartford, Connecticut, inhaled the nitrous oxide gas with the view of rendering himself insensible during the extraction of a tooth; and, finding the experiment succeed, repeated it on several of his patients. Its success was not, however, permanent; and having failed in several cases, he seems to have given up the attempt. In 1846 Dr. Morton, a dentist, and a pupil of Wells, used the vapor of ether instead of the nitrous oxide gas; and, having succeeded in extracting several teeth painlessly, applied to the authorities of the Massachusetts General Hospital at Boston for permission to administer it to a man from whom Dr. J. C. Warren was about to remove a tumor of the neck. The result was most successful; and from that time the use of anæsthetics has been established in surgical practice in every civilized country in the world.

For more than a year, sulphuric ether was the only agent used for inducing anæsthesia. But in 1848 Simpson, of Edinburgh, discovered the anæsthetic properties of chloroform; and in this country this agent soon came to be generally employed, although ether held its ground with the American surgeons, by many of whom it is preferred to chloroform at the present time. Within the last year, the use of nitrous oxide has been revived.

The employment of *anæsthetics* in surgery is undoubtedly one of the greatest boons ever conferred upon mankind. To the patient it is invaluable in preventing the occurrence of pain, and to the surgeon in relieving him from the distress of inflicting it. Anæsthesia is not, however, an unmixed good. Every agent by which it can be induced produces a powerful impression on the system, and may occasion dangerous consequences when too freely or carelessly given; and even with every possible care, it appears certain that the inhalation of any anæsthetic agent is in some cases almost inevitably fatal. We cannot purchase immunity from suffering without incurring a certain degree of danger. There can, however, be little doubt that many of the deaths that have followed the inhalation of anæsthetics have resulted from want of knowledge or of due care on the part of the administrators. Yet, whatever precautions be taken, there is reason to fear that a fatal result must occasionally happen. This immediate risk, which is but very small, is more than counterbalanced by the immunity from other dangers during operations which used formerly to occur.

There is, however, another question in relation to chloroform which deserves the most serious consideration on the part of the surgeon; viz., Does it influence the rate of mortality after operations? On this point there is conflicting testimony. Simpson has published statistics to show that the mortality after operations has lessened since the introduction of chloroform. J. Arnott, on the other hand, adduces figures to prove that it has materially increased, in amputation by 12, in lithotomy by as much as 28 per cent. I am inclined to believe that the rate of mortality has increased since the use of chloroform in operative surgery. But is this increase altogether due to any effect produced on the system by the inhalation of chloroform? May it not, in some measure at least, be owing to operations being often performed in very doubtful or extreme cases, now that they can be done painlessly, when formerly the suffering inflicted would have deterred the surgeon from proposing, or the patient from acceding to, their performance? A surgical operation was formerly, from the pain attending it, looked upon as a more serious affair than

it is at the present day, and surgeons were not willing to inflict suffering unless there were a good prospect of a successful issue. Now, however, that the most serious operations can be performed without any consciousness to suffering, the surgeon, in his anxiety to give his patient a chance of life, may not unfrequently operate for disease or injury that would otherwise necessarily and speedily be fatal, and which formerly would have been left without an attempt at relief.

Making, however, all allowance for the extension of operative surgery to extreme cases that were formerly not thought to come within its range, I cannot but think that chloroform does exercise a noxious influence on the constitution, and does lessen the prospect of recovery in certain states of the system, more especially when the nervous power is enfeebled or the blood is in an unhealthy state. In such circumstances, the depressing influence of chloroform appears to me to act injuriously; the patient does not rally well after the operation for which it is administered, and immunity from suffering is purchased by a lessened chance of recovery.

[From the opening of the Pennsylvania Hospital to the year 1858, inclusive, 96 cases of vesical calculus were operated on by lithotomy with a mortality of 14 or 14.6 per cent. These cases were all operated on without the use of anæsthetics. Since 1858 there have been 15 lithotomies (done with anæsthesia), with 4 deaths, an increased mortality of 27 *per cent.* (*Penna. Hosp. Reports*, vol. ii. p. 37.) Though as observed by the reporter, Dr. Morton, this great discrepancy is not solely attributable to the use of anæsthesia, the figures above quoted certainly tend to confirm the views of the author, that anæsthetics are not agents of unmixed good.—A.]

Anæsthesia by the Administration of Chloroform is best commenced before the patient leaves his bed. The chloroform should never be given but by a person accustomed to its use, and on whose capability the surgeon has full reliance; as nothing embarrasses more, during an operation, than to have any doubt about the chloroform being properly administered. Chloroform may be administered in many different ways, either on lint or a handkerchief, or through an inhaler of some kind. The following is the way in which chloroform may most safely be given on lint or a handkerchief, without apparatus of any kind. On a piece of folded lint, about two inches square, and consisting of three doubles, about a drachm of chloroform is poured; and the lint is then held at a distance of about three inches from the nose of the patient, so as to permit a very free admixture of air with the first few inhalations of the vapor. After the lapse of about half a minute, the lint is brought nearer to the patient's nose, to within a distance of perhaps an inch, being never allowed to touch; at the same time a porous towel, not doubled, is lightly laid over the face of the patient and the hand of the operator, so as to prevent the escape of the chloroform vapor, but not to interfere with the admission of air. During the whole time, it is the duty of the administrator to keep his hand on the pulse, to watch the breathing, and occasionally to examine the pupils of the patient.

The method just described (giving chloroform on lint, the patient's head being covered with a towel) answers well enough in most cases, but it affords no means of ascertaining the proportion of chloroform which is being inhaled by the patient. The administrator can judge only by the effects produced. There is a danger of the patient's lungs being filled with a very strong mixture at the moment when the signs of an overdose are first perceived. In the most favorable circumstances, it requires several respirations to replace the strong dose by fresh air; but if the patient happen to be in a rigid state, or his glottis be closed by spasm, considerable delay will occur, during which time, if the dose have not been strong enough to arrest the action of the heart, the blood is passing through the lungs and becoming further charged with chloroform.

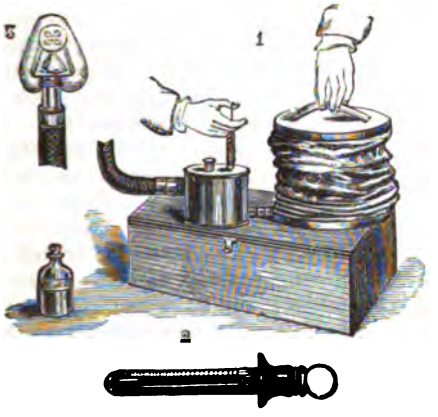
Various inhalers have been contrived for the purpose of regulating the proportion of chloroform with accuracy. The simplest kind consists of a mask covering the nose and mouth, with a box for sponge or blotting-paper on which the chloroform is poured, and with valves to prevent the expired air from passing through the chloroform-chamber. The objection to this form is, that it yields a very strong mixture at first; and, when the chloroform has half evaporated, the remainder is so cooled that it evaporates too slowly to yield enough chloroform to insure the quietude of the patient, especially if he should move his head about so as to get a small quantity of air between his face and the mouthpiece.

Dr. Snow improved this apparatus by surrounding the chloroform-chamber with water, and also making the upper valve movable so that at the beginning of the

inhalations only a portion of the inspired air should pass over the chloroform. This was a great improvement; but accuracy was not secured, because the proportion of chloroform given up varies with the temperature of the room, with the slowness or rapidity of the patient's breathing, and with the cooling of the chloroform, which is not entirely prevented by the water-jacket.

My experience with Mr. Clover's instrument is of the most favorable character. I have had chloroform administered to several hundreds of my patients by it, without accident or cause for anxiety. It consists of a bag holding 8000 cubic inches of air, which is suspended from the coat-collar at the back of the administrator, and connected with the face-piece by a flexible tube (Fig. 3). The bag is charged by means of a bellows (Fig. 2, 1) measuring 1000 cubic inches; and the air is passed through

Fig. 2.



Clover's chloroform apparatus.

Fig. 3.

Administration of chloroform by Clover's apparatus.

a box warmed with hot water, into which is introduced, at each filling of the bellows, as much chloroform as is required for 1000 cubic inches of air. This is done with a graduated glass syringe (Fig. 2, 2) adjusted by a screw on the piston-rod to take up no more than the quantity determined on, which is usually from 30 to 40 minims.

When the bag is full enough, the tube is removed from the evaporating vessel, and the mouthpiece (Fig. 2, 3) adapted to it.

The patient cannot get a stronger dose than the bag is charged with; but the proportion can be made any degree weaker, by regulating the size of an opening in the mouthpiece, which admits additional air.

The principal points to be attended to during the inhalation of this potent agent are, that it be not given too suddenly, or in too concentrated a form; and that, whilst under its influence, the patient be not raised into the erect or sitting position. If lint be used, it may be too much saturated, and be held too closely applied to the mouth and nostrils; and the patient will not be able to get sufficient atmospheric air, and may speedily become partially asphyxiated, choking violently, struggling to get free, and becoming purple in the face, with a full slow pulse. Care should be taken not to compress the abdomen in holding the patient; for, as the respiration becomes chiefly or wholly diaphragmatic, it may be seriously interrupted by any pressure on the abdominal wall. Whilst under the influence of chloroform, the patient should never be raised up, as has just been stated; for, as this agent exercises a powerful sedative action on the heart, sudden and perhaps fatal syncope may ensue from putting the patient in the erect position. Hence, also, it is dangerous to administer it in those operations that require to be performed whilst the patient is erect. It is well to caution the patient not to take anything to eat for two or three hours before its administration, lest it induce vomiting of the partially digested meal. With due caution, it may be given with perfect safety to individuals of all ages. I have operated on infants less than a week old, as well as on octogenarians, under its influence. In administering it to young children, Dr. Snow recommends its dilution with rectified spirit.

The first influence of chloroform appears to be exercised upon the nervous system. The patient becomes excited and talkative, and a state of unconsciousness is

induced, the muscular system at the same time being rendered rigid and tense. At this time the heart's action is usually quickened, and more forcible than natural. As the administration of the chloroform continues, however, complete paralysis of sensation and motion is induced. The patient becomes altogether unconscious to all external impressions, the muscles become relaxed, and the action of the heart slow and feeble. This diminution in the power of the heart's action is well marked in the lessened force of the jet of blood from cut arteries. The respirations become shallow and feeble, in proportion as the sensibility of the nervous system and the energy of the muscular movements are lessened, and the blood in the arteries becomes dark; in fact, a semi-asphyxial state sets in. When thus fully anæsthetized, the patient is undoubtedly on the very verge of death, and requires the most careful watching by the person who administers the chloroform; his fingers should never be off the pulse, nor his eyes taken away from the countenance of the patient. The breathing should be very carefully observed: when it becomes embarrassed chloroform must be given sparingly, and when it becomes stertorous it should be discontinued entirely. In this state the inhalation of a small additional quantity of this potent agent, the application of the vapor in too concentrated a state, or the sudden raising up of the patient, might occasion death from paralysis of the heart.

If the inhalation of chloroform have been suspended, great care should be taken when its administration is recommenced, lest the already enfeebled heart be entirely overpowered by the influence of too large a volume of vapor suddenly given in a concentrated form.

It should be borne in mind that it is not necessary in all operations to administer chloroform to the same extent. In all the greater operations, as amputations, lithotomy, and the ligature of arteries, enough should be given to completely paralyze muscular movement, as well as to suspend sensibility and consciousness. In operations for hernia, also, and all other proceedings implicating the abdominal walls, if complete muscular relaxation be not induced, great inconvenience and not a little danger may result. So, also, in very painful operations about the anus and genital organs, a full dose of chloroform should be given. But for the removal of many tumors about the trunk, or in many of the minor operations on the extremities and about the head and face, muscular relaxation is not so necessary; and it will be sufficient to give enough chloroform merely to suspend sensibility and consciousness to pain.

In certain diseased conditions of the system the administration of chloroform requires much care; but, as a general rule, it may be stated that, whenever the constitutional disease has not advanced to such a degree as to contraindicate an operation, chloroform may be given. In the early stages of phthisis it may usually be safely inhaled; but in some cases of bronchial irritation the vapor is apt to produce troublesome cough. When the heart is diseased, great caution is necessary, more particularly when its muscular substance has undergone fatty degeneration; the sedative influence of the chloroform being apt, in these circumstances, to produce a sudden depression or arrest of the heart's action. In many, perhaps the majority, of the cases of death from chloroform, the fatal event has been traced to this cause. In valvular disease of the heart I believe that it may be more safely given. In persons who are epileptic, and in those who suffer from congestion of the brain, it requires to be cautiously administered, as in the earlier stages of anæsthesia much cerebral excitement is apt to be evinced. In hysterical subjects, chloroform is said to induce a tendency to laryngeal spasm. The most dangerous condition in which to administer chloroform is that in which in consequence of renal disease, the blood is loaded with urea; in such cases epileptiform convulsions are readily induced, with lividity of the face, and a tendency to stertor and coma.

Should chloroform be given in operations rendered necessary by severe injuries, during the period of the continuance of the shock of the accident, as in primary amputations? In such circumstances, its use has been objected to on the ground that it would act injuriously by still further lowering the already depressed vital powers; and that the pain of the operation, if performed without it, would prove a good stimulant, and thus serve to rouse the patient. But would this really be so? Is the pain of an operation a stimulant? In order to answer this question, let us observe the condition of a patient immediately after the performance of a severe operation—as an amputation—without his having been anæsthetized; and we shall find that, so far from having been restored or stimulated, he will have been seri-

ously depressed by it. The pulse will be small, feeble, and slow; the surface cold; and the mind, perhaps, scarcely conscious: in fact, though a slight degree of pain, as a pinch or a prick, may act as a stimulant, very severe suffering is a most powerful depressing agent, capable in itself of destroying life. The pain of an operation performed soon after the occurrence of a severe injury, so far from rousing the patient, appears to me to act most injuriously, by inflicting a second shock upon the system before, perhaps, it has fairly recovered from the depressing effects of the first; and it is by preventing this that chloroform is of such inestimable advantage. In these cases it is not necessary to give chloroform to an extreme degree of anæsthetization. It is only requisite to give it to a moderate extent, chiefly so as to benumb sensation during the incisions made through the skin. After this, and during the later stages of the operation, the inhalation may be suspended entirely, or nearly so.

Secondary effects of chloroform may develop themselves in connection with the *head*, the *lungs*, or the *stomach*. The liability to inconvenient secondary effects depends chiefly on two conditions: 1, on the mode of administration of the chloroform, especially on the care taken that there is an adequate supply of air admitted at the time when the vapor is inhaled; and 2, on the state of the patient as to age, habit, temperament, and digestion. Old people, habitual spirit-drinkers, and those of a bilious and sanguine temperament, are apt to suffer most. The condition of the digestion is of great importance. If chloroform be given too soon after a meal, injurious results are sure to follow; hence, it is best administered on an empty stomach.

Head-complications chiefly follow the administration of chloroform in the aged. In them headaches and stupor not unfrequently supervene, and occasionally paralytic or apoplectic symptoms will develop themselves some days after the anæsthesia. In young and nervous women hysterical symptoms often appear, and continue for some hours, or even days; but they need not excite uneasiness.

The *lungs* probably always become congested during the administration of chloroform. But, as recovery takes place, and the respiratory process is naturally re-established, the pulmonary vessels unload themselves, and no inconvenience results. The process is greatly facilitated, and the effects of chloroform are readily got rid of, by desiring the patient to breathe several times fully and deeply after consciousness returns. In some cases the lungs do not unload themselves of the accumulated blood; and a process of slow asphyxia or a low form of pneumonia may set in, and may prove fatal in from twenty-four hours to four or six days. This is especially apt to happen in those cases in which it becomes necessary to bandage the chest, or in which deep respiration is attended by pain, as after amputation of the breast. Great care must, therefore, be employed not to adopt too much constriction of the chest-walls after such operations.

Irritability of the stomach, attended by continual nausea and vomiting, is sometimes a very distressing after-consequence of chloroform, and may be productive of most serious and even of fatal results. In many instances it is developed by the patient taking the chloroform too soon after a meal, and is then purely gastric. In other instances, it appears to be sympathetic with cerebral disturbance of some kind; in other instances, again, it is connected with kidney disease. But in any case, and from whatever cause arising, it is a very serious symptom, and, if it continue, often turns the scale against the patient by the exhaustion to which it gives rise. It is best treated by ice and opium.

Death from chloroform may occur in three different ways—viz., by *coma*, by *asphyxia*, or by *syncope;* through the brain, the lungs, or the heart.

When death occurs by *coma*, the patient is heard suddenly to breathe stertorously; he becomes livid in the face, and is convulsed; the heart continues to beat until the last moment of life, and death appears to result primarily from the circulation of dark blood through the nervous centres. This form of death chiefly occurs in individuals who are epileptics, or whose blood is loaded with urea. When death occurs by *asphyxia*, it is the fault of the administrator, sufficient air not being admixed with the chloroform vapor to maintain the respiratory function. The symptoms are those of ordinary asphyxia, consisting of lividity of the surface, distension of the jugulars, struggling for breath, and speedy cessation of the heart's action. In some cases death is not immediate, but a low form of congestive pneumonia sets in, the blood never becomes properly aërated, and death ensues in a few days, the direct effects of the chloroform never having completely gone off. In death from *cardiac*

syncope, the patient, after a few inspirations, suddenly becomes pale and faint; the pulse beats in a flickering manner a few times and then ceases, though respiration may continue; the fatal event being evidently due to paralysis of the heart. This is an accident that may occur to individuals who are depressed either by mental emotion or by physical debility before taking the chloroform; and it is not unfrequently connected with a fatty heart. It is best guarded against by giving the patient a little stimulant, as brandy or ammonia, before commencing the inhalation.

The *treatment of the effects arising from an overdose of chloroform* is conducted on two principles: 1, the establishment of respiration, either natural or artificial, so as to empty the lungs of the vapor contained in the air-cells, and to aid the oxygenation of the blood; and 2, the stimulation of the heart's action, and the maintenance of the circulation.

The first principle of treatment—that of re-establishing respiration—is most serviceable in the asphyxial form; the other—that of stimulating the heart—when the syncopal symptoms are present. But in all cases they may most advantageously be employed in combination.

The treatment to be adopted on the occurrence of dangerous symptoms, or of apparent death from chloroform, is as follows:—

1. The administration of the vapor must be at once discontinued.
2. The tongue should be seized with the fingers, or with a hook or forceps, and drawn out of the mouth; and the larynx pushed up so that the glottis may be opened.
3. Fresh air should be admitted to the patient by opening doors and windows, and by preventing bystanders or spectators from crowding round.
4. All constrictions should be removed from the patient's throat and chest, and these parts should be freely exposed.
5. Artificial respiration must *at once* and without delay be set up, whilst these other measures are being carried out, either by the surgeon applying his mouth to the patient's lips, and thus breathing into the chest; or, what is preferable, by the alternate and steady compression and relaxation of the walls of the patient's chest.
6. Electricity should be applied freely over the heart and diaphragm through to the spine, by means of the electro-magnetic or other convenient apparatus.
7. As accessory means, friction of the extremities may be employed; a little brandy rubbed inside the mouth, and cold water dashed on the face.

The *administration of ether* is effected by the application over the nostrils of a hollow sponge saturated with the best washed ether. This mode is preferable to the use of any of the complicated inhalers; inasmuch as, by the admixture in the sponge of a sufficient quantity of atmospheric air with the ethereal vapor, all danger of asphyxia is avoided. To prevent the pungent effects of ether on the cutaneous surface, Dr. Warren has proposed the anointing of the face with some protective unguent. The first effects of the inhalation are resistance on the part of the patient, and some slight irritation of the air-passages; the pulse is increased in rapidity, rising to one hundred pulsations per minute; the face becomes flushed, and the movements and speech of the patient excited. This stage of excitement soon passes, and full etherization is then effected; the pulse falls to sixty or seventy, the countenance becomes pale, insensibility to pain is produced, and the whole muscular system is relaxed. The indications of this state are the dropping of the upper eyelid, and the inability of the patient to sustain his arm when raised. This is the period most favorable to the performance of operations, and especially for the reduction of dislocations and of fractures attended with shortening of the limb. The time required for the induction of the anæsthetic state varies; averaging, perhaps, about five minutes, a longer period than is required in the administration of chloroform, and attended with slightly more excitement. The fatal consequences which have attended the employment of chloroform have caused the American surgeons almost entirely to trust to ether in preference. Ether is certainly a safer agent than chloroform, but few deaths having resulted from its administration; and the only argument in favor of the use of chloroform rather than ether is, that chloroform is the most *convenient* agent, its effects being produced more quickly, and no disagreeable smell being left, as is the case with ether.

[Several forms of inhalers have recently been devised for the purpose of diminishing the amount of ether required to produce insensibility. One of the most ingenious of these is that employed by Dr. Albert H. Smith, of Philadelphia, and

described in his edition of Ellis' *Medical Formulary*. It consists of a large India-rubber ball (such as is sold for a foot-ball) lined with patent lint, and with an aperture cut for the face. The apparatus usually employed at the Episcopal Hospital consists simply of a large sponge, surrounded with a pasteboard cone to prevent the escape of the vapor. While agreeing with the majority of American surgeons in preferring ether to chloroform for most cases, it is but right to say that there are certain classes of operations where the latter anæsthetic should be employed rather than its usually safer rival. In certain operations about the eye, such as the extraction of cataract, chloroform is much preferable to ether, as less likely to produce sudden vomiting. Also in any case where it may become necessary to use the actual cautery about the face, ether should be avoided, as its vapor is very inflammable; patients have sometimes been seriously burned through a neglect of this precaution. Some surgeons hope to avoid the dangers and gain the advantages of both ether and chloroform by administering a mixture of the two. I have never seen any reason to prefer such a combination to ether alone, while I have seen in at least one instance where this mixture was used, such serious symptoms follow as required the abandonment of the operation and the employment of artificial respiration to resuscitate the patient.—A.]

Many liquids, when volatilized, have the property of inducing anæsthesia, and have been recommended for this purpose; but hitherto no substance has been found which is so convenient, or on the whole so safe as ether and chloroform.

Nitrous oxide gas has been introduced of late as an anæsthetic by American practitioners. It is undoubtedly capable of producing insensibility to suffering; but as, owing to the asphyxial condition which it induces when administered in a pure state, its inhalation cannot be continued with safety beyond a very few minutes; it only appears to be applicable to those cases in which the operation is of short duration, such as the extraction of teeth. The anæsthetic effects of this agent completely pass off almost as soon as the patient ceases to inspire it; hence it is not very applicable to cutting operations, in which the after-smarting is often as much complained of as the actual sting of the cut. Upon the whole, it is far inferior to ether or chloroform as an anæsthetic in all ordinary surgical cases.

Local anæsthesia may be induced by freezing a part. This is done in two ways: 1, by the application of a freezing mixture; 2, by the rapid evaporation of very pure ether. The application of a frigorific mixture of ice and snow, as introduced by Dr. J. Arnott, may very conveniently be employed in many cases in which the internal administration of anæsthetics is either inadmissible or inconvenient. It can only be produced with certainty, however, in those cases in which the incisions merely implicate the skin and subcutaneous structures, as in opening abscesses, slitting up sinuses, avulsion of toe-nails, or removing small and superficial tumors. For all such purposes, however, it is extremely valuable.

The mode of using the *frigorific mixture* is as follows. About a tumblerful of rough ice is put into a strong canvas bag, and finely powdered with a mallet. It is then poured out on a sheet of paper, and half its bulk of salt is quickly mixed with it by means of an ivory or wooden paper-knife. The mixture is then put into a muslin or gauze bag, suspended from a wooden ring, and applied to the part for from five to ten minutes. So soon as the skin becomes white, opaque, and hard, anæsthesia is produced, and the incisions may be made without any pain being experienced. The frozen part speedily recovers itself, no inconvenience resulting.

The *rapid evaporation of highly rectified ether* has been very ingeniously and successfully applied by Dr. Richardson in the production of cold sufficient to freeze a part, and thus render it temporarily insensible. A fine spray-jet of ether of a low specific gravity is thrown upon the part to be anæsthetized. The skin rapidly becomes white and hard—is, in fact, frozen. This method of inducing local insensibility to pain is more exact and efficacious than that by the frigorific mixture, and is generally preferred. It is applicable in the same class of cases.

[Local anæsthesia by means of the ether spray is not free from danger; in a case of excision of the tunica vaginalis for hydrocele, which occurred in this city, extensive sloughing of the scrotum was produced by the excess of cold, and the patient narrowly escaped with his life.—A.]

Performance of an Operation.—The *incisions* for the operation itself should be carefully and properly planned, so as to give sufficient space with as little mutilation as possible; and in some cases they must be arranged with the view of subse-

quent extension, should the state of things to be discovered require it. They should be made freely, without tailing; the point of the knife being entered and withdrawn perpendicularly, and made to cut with a rapid sawing motion, due attention being at the same time paid to the resistance of the tissues, so that the surgeon may not, by using too much force, plunge or jerk his scalpel or bistoury into the part. The scalpel should be set on a smooth ebony handle, which is less slippery than an ivory one when wetted with blood, and admits of greater delicacy of touch; it should be light in the blade, nearly straight-backed, and slightly bellied on the cutting edge. When very free and extensive incisions are required, as in the removal of large tumors, &c., Liston's spring-backed bistoury, of proper size and shape, is a most convenient instrument. Whilst the incisions are being made, care must be taken that too much blood is not lost. This may be prevented most conveniently by the use of the tourniquet, or by an assistant compressing the main artery of the limb. If the seat of the operation be such as not to admit of this, the assistant must compress the bleeding vessels, as they are divided during the operation; and as soon as it is concluded he must remove his fingers from them one by one, to admit of their being ligatured, or the hemorrhage arrested by acupressure. If oozing continue after all jetting vessels have been tied, it may be arrested by exposure to the air, or by pouring a stream of cold water upon the wound. In some cases the pressure of a pad and bandage, and in others that of a sand-bag, will arrest this bleeding; but in the majority of instances, position and coaptation of the flaps will suffice.

[Various styptics have been proposed for this purpose, but, perhaps, the most simple and one of the best, is a mixture of equal parts of alcohol and water.—A.]

The *sutures* should be introduced at the time of the operation, whilst the patient is still under chloroform. If the wound be dressed at once, they are tied in the usual way, and the edges thus brought neatly together. If the dressing of the wound be deferred for a few hours, they should be left to hang loose, and not be drawn tight until the wound is dressed. In this way the patient is saved the pain, which is always much complained of, of introducing the sutures at the time of the dressing. They are generally best made of dentists' twist of moderate thickness, so as not to cut out readily. Silver or unoxydizable iron wire forms an excellent material for sutures in the plastic operations, and in many other cases in which the silk thread is apt to irritate. In some cases, where much tension is exercised, or great accuracy required, hare-lip pins are preferable to ordinary sutures.

[Lead is for most cases a preferable material for sutures to either silver or iron. It will break if much tension be exercised, and is thus a kind of safety-valve in cases where much swelling takes place after the adjustment of a wound.—A.]

Dressing of the Wound.—When the wound is small, and all oozing has ceased, its lips may at once be brought together. This may also be done, even when it is large, if the patient be of a very irritable constitution and sensitive to pain; the whole dressing being performed whilst he is still under the influence of chloroform. But in general, when the wound is extensive, as in cases of amputation, I prefer, and almost invariably adopt, the plan recommended by Mr. Liston, of leaving the wound open with a piece of wet lint interposed between its lips, for two or three hours, until its surface has become glazed; the lint is then carefully removed, any small coagula are gently taken away, and the sides of the incision brought into apposition, the sutures being drawn tight and tied. Long strips of plaster of moderate width should now be applied; these may be either of the isinglass or the common adhesive kind, each having advantages that recommend it in particular cases, with corresponding disadvantages that exclude it in others. The isinglass plaster is clean, unirritating, and, being transparent, allows a good view of subjacent parts; but it has the disadvantage of loosening and stripping off when moistened by the discharges or dressings, which often renders it a very inefficient support. The common adhesive plaster is more irritating and dirty, but it is much stronger and holds tighter, not loosening so readily when moistened. In large wounds, as in those of amputation, I prefer the isinglass for the first dressing, and leave it on until loosened by the discharges, and then use the common adhesive plaster for subsequent applications, when less irritation is likely to be induced. In some cases, in which the wound is in such a situation as to admit of it, and more particularly if it be a deep though clean cut—as after the extirpation of tumors—great advantage will be found after the sutures have been introduced and the plasters applied, in

padding the part externally with a firm compress of dry lint, and then applying a roller tightly but evenly over all, so as to compress the sides against the bottom of the wound and the edges firmly one against another. In this way will not only all oozing be prevented, but direct coalescence and union of the opposed surfaces may be secured. This dry compress may be left undisturbed for forty-eight hours, when it should be removed and another applied, or, if it appear more desirable, the part covered with water-dressing.

[A very neat and efficient dressing for certain wounds, especially those of the scalp, is the gauze and collodion dressing introduced into this city by the late Dr. Paul B. Goddard. In cases where there is much hemorrhage the "styptic colloid" of Dr. Richardson may be advantageously substituted for the ordinary collodion.—A.]

The *position* of the part should be carefully attended to, so that the edges and surfaces of the incision be brought into proper contact; more may be done in this way, without pain or uneasiness to the patient, than by any amount of traction and pressure that can be exercised. The part should be so arranged that one end of the incision may be the more dependent, so as to facilitate the escape of discharges. One end of each ligature should be cut off short, the other being left of a moderate length to hang out of the lowest part of the wound, provided that the thread do not lie along its whole line. A narrow strip of water-dressing should then be applied along the edge of the incision. The first dressings need not be changed until about the third day after the operation, unless they become loose or are too tightly applied, when they may be snipped across. About this time, or earlier in many cases, a serous bloody fluid will be discharged from between the strips of plaster and the sutures. The escape of this must be facilitated by removing any obstacles that are in its way. If, however, the sutures do not interfere with the escape of the discharges, and do not produce undue irritation or excessive traction, they may be left in for a few days longer. In amputations, especially in cachectic subjects, they may frequently be left undisturbed for six or eight days, with much advantage.

If union do not take place by adhesive inflammation, and suppuration have commenced, with much tension and heat about the part, the substitution of a poultice for the water-dressing will be advantageous. When suppuration has fairly set in, the applications should be changed at least twice or thrice in the twenty-four hours. The neglect of this precaution often gives rise to much irritation, and retards the healing process by the accumulation of discharges in and around the wound. Care should also be taken that there is a free escape for the pus, which may sometimes be pent up by the too early cohesion of the edges, without a corresponding agglutination of the deeper surfaces of the wound. As granulations spring up, it may become necessary to substitute astringent dressings for the emollient ones; and the parts must be well supported by bandages, especially in amputations, and in all cases where there is a tendency to bagging of matter.

[Sir James Y. Simpson has highly recommended the exposure of wounds to the air without any dressing whatever. M. Guérin, on the other hand, advocates placing wounds in the vacuum of an exhausted receiver, a process which he designates by the name of "pneumatic occlusion." The antiseptic plan of treatment of Prof. Lister, in which carbolic acid plays a prominent part, has lately deservedly come into great favor. Few dressings will however be found in practice more satisfactory than the alcoholic dressing, whether in the form of tincture of opium or of simple dilute alcohol, as employed extensively by French surgeons. Water-dressing, as recommended by the author, was so grievously abused by American surgeons during the earlier years of the late war, that it has fallen into perhaps greater disrepute than it has deserved.—A.]

The *constitutional after-treatment* of operations demands as much attention on the part of the surgeon as the management of the wound itself. Immediately after the operation, and before the effects of the chloroform have passed off, the patient should be comfortably arranged in bed, with the clothes supported by a cradle, or other contrivance, away from the part implicated; an opiate should then be administered, or a little wine and water if there be faintness, and the patient kept as quiet as possible.

With regard to the *diet after the operation*, this must depend entirely on the patient's constitutional powers, his previous habits, his age, and upon the severity of

the operation. But, as a general rule, it may be stated that, as an operation is a shock to the system, the constitutional powers usually require to be maintained after its performance. This is more particularly the case, if the mutilation be severe or the subsequent suppuration abundant. If the patient's strength be good, not having been broken by previous disease or suffering, and if the operation be a slight one, as the amputation of a finger, or the removal of a small tumor, he may have half his usual diet allowed for a few days, but without any stimulants. If the operation have been more severe, but not capital, no solids should be allowed, but broths and nourishing liquids alone given for the first few days. If the operation have been a capital one, the patient's health and strength being otherwise good, he may be restricted to farinaceous slops and beef-tea until suppuration has come on; indeed, up to this time, the febrile reaction will usually prevent the patient from taking solids. Some light pudding may then be added; and the diet may, as the case progresses, be gradually improved by the successive addition of fish and the lighter kinds of meat, with a moderate quantity of stimulants, as required, until it reach the normal standard. It not unfrequently happens, however, that a totally different course must be pursued. If the patient have been much reduced by a long-continued suppuration, or other depressing causes before the operation; if he be old and weakly in constitution, or have been in the habit of taking a very considerable quantity of stimulants, it will be absolutely necessary to depart from the routine plan, and to adopt a tonic and stimulating mode of treatment. Indeed, in hospital practice especially, I find this by far the most successful mode of treating patients after severe operations; without it, many would have sunk, whom I have seen saved by the free administration of large quantities of brandy, wine, porter, eggs, and beef-tea, from the very time of the operation; that stimulant being given to which the patient is accustomed in a state of health. I believe also that this plan of treatment is the best preventive of those low and diffuse forms of inflammation that are so commonly fatal in these cases; and when they come on, I know of no better remedy than the brandy-and-egg mixture of the Pharmacopœia, freely administered. In all this, however, the surgeon must be guided by the patient's pulse, his previous habits, and the power of his constitution; and nothing requires greater judgment than the administration of stimulants, according to these particulars. The great importance of attending scrupulously to the general cleanliness of the patient, and to the ventilation of the ward or room in which he is lying, as the best means of preventing the occurrence of the lower forms of inflammatory mischief, need scarcely be insisted on, as these hygienic precautions are universally recognized as being of the first importance under such circumstances.

The various Special Operations will be considered when treating of the several Injuries and Diseases for which they are required; but, as Amputations do not readily fall under any special head, being required for a vast variety of different conditions, it will be more convenient to consider them here.

CHAPTER II.

AMPUTATIONS AND DISARTICULATIONS.

The term *Amputation* properly means the separation of a limb from the body, but it is sometimes applied to the removal of other parts, as the breast or penis. The frequency of amputations of the limbs has much lessened of late years; other and less severe modes of treatment being now successfully followed in many cases of diseased joint, of aneurism, and of compound fracture, that were formerly submitted to the knife. But still amputations are amongst the most frequent operations in surgery, and will continue to be so as long as the human body is liable to severe mutilations, to gangrene of the limbs, and to malignant and other incurable diseases of the bones and joints. It has been somewhat the fashion to decry amputation; and to speak of this operation as an opprobrium to curative surgery. But, though no surgeon can deprecate unnecessary amputations more

strongly than I do, yet I cannot admit that the removal of a limb differs from other operations, which are only attempted when all other means have failed in curing the diseased part, or saving the patient's life. And, surely, it is rather a subject of just pride than the reverse, for the surgeon to be able with ease, and by a simple operation, to save the whole of the body, though he sacrifice a limb that has been utterly and incurably disorganized or spoilt by disease or injury. In the performance of an amputation, also much dexterity may frequently be displayed; and there is commonly great scope for surgical skill in the constitutional treatment of the patient both before and after the operation.

An amputation may be done in the continuity of a bone; or at a joint, when it is called a *Disarticulation.*

Hemorrhage during the operation is the great primary danger which must be carefully guarded against. As a general rule, it is better to prevent this by the application of a tourniquet than by trusting to the compression of the artery by an assistant's fingers; the tourniquet arresting the flow of blood through the collateral vessels as well as through the main trunk, whilst the finger can only stop the current of blood that passes through the latter. When the tourniquet is applied, the pad should be carefully placed over the artery, and the band buckled rather tight; but the instrument should not be screwed up until the moment of the operation. It should then be tightened rapidly, so as to lessen the liability to congestion of the lower part of the limb that always occurs when a tourniquet is applied, but which is especially apt to ensue when the instrument is slowly screwed up. The first effect of the tightening of the tourniquet is to compress the large veins of the limb; the second, to arrest the flow of blood through the arteries: hence the more slowly it is caused to act, the greater will be the venous engorgement of the limb. The blood that flows from the limb during an amputation is almost entirely venous, from the lower part of the member. In those cases, as of chronic disease, in which it is of great importance to save blood as much as possible, it is a good precaution either to keep the limb raised for a few minutes before the application of the tourniquet, or to bandage it tightly from below upwards immediatedy before the tourniquet is applied; thus preventing, to a great extent, the venous congestion. So soon as the main arteries have been tied after the removal of the limb, the tourniquet may be unscrewed and taken off; the assistant, however, keeping his finger on the artery above the stump, lest any vessels have been left untied, or a ligature slip. If the band be left only half loosened, it will often happen that venous hemorrhage continues abundantly from the stump, in consequence of the pressure of the instrument being still sufficient to prevent the return of the blood through the veins. This will at once cease on taking the tourniquet completely off, and elevating the cut surfaces.

In amputations and disarticulations, the surgeon has the choice of four *Operative Procedures:* (1) The circular method; (2) the oval method; (3) flaps of various sizes and shapes; and (4) a combination of skin-flaps with a circular cut through the muscles. It is not my intention to enter into a discussion as to the relative merits of the *circular* and *flap* methods, for which I would refer to the writings of Liston and Velpeau. I believe that by either the circular or the flap method an equally good stump may ultimately be formed; but that much will depend upon the special dexterity which the surgeon may have acquired by the habitual performance of one or other of these operations. Educated in the doctrines of Mr. Liston, who invariably amputated by the flap method, and who certainly did this with wonderful rapidity and precision, I have been in the habit of performing this operation in preference to the circular, over which it certainly possesses the special advantages of greater celerity in performance, more perfect coaptation and smoothness of the opposite sides of the wound, and a greater tendency to union of the stump by the first intention.

The *oval* method is especially applicable to certain amputations and disarticulations of the bones of the hand and foot. It presents no advantage in the larger amputations.

Flap Amputation.—In performing flap amputations, the surgeon should always stand so that he may support and grasp the limb to be removed; the left hand being placed on the outer side in amputations of the left limbs, on the inner side in those of the right.

The *amputating instruments* must be in proper order, and of good construction. For the smaller amputations the surgeon will require straight spring-backed bis-

touries, narrow or broad in the blade, according to the size of the part to be removed. Scal-pels, also, not too broad in the blade, are useful in cases in which the bistoury, from its length, might be inconvenient. Cutting-pliers, with long and strong handles and short blades, either straight or curved, as may be most convenient, are especially required in amputations about the hands and feet. The knives for the larger amputations should have smooth ebony handles, and be well balanced. The back of the blade should run straight to the point and be well rounded. The edge should taper off towards the point, with a good convexity. The breadth of the blade should vary from $\frac{3}{4}$ to $\frac{7}{8}$ of an inch, and its length should be proportioned to the thickness of the limb to be removed. As a general rule, in order to make a good sweeping cut, so as to form a well-rounded and smooth flap, the blade should be in length equal to about double the thickness of the limb. The saw should be strong in the blade and back, so as not to bend in cutting. The blade must be of good breadth, and, in order not to hang as it works its way through the bone, must be somewhat thicker at the cutting edge than elsewhere. The teeth should not be too fine, and must be set crossways. The artery-forceps may either be of the ordinary "bulldog" make, or may be broad towards the point, so as to allow the knot more readily to be slipped over the vessel to be tied.

Amputations by flaps fashioned from the soft parts so as to cover the bone and form a well-cushioned stump may be performed in several different ways: by double flaps, by one long rounded flap, or by one long and one short square flap.

The *double-flap amputation* is that which is usually practised, and that which we shall first consider.

The two flaps may be made either by cutting from without inwards, or by transfixion—cutting from within outwards. I generally prefer transfixion in fleshy parts, as the thigh or arm; but cutting from without inwards will be found to afford the best result, and is indeed the only mode of forming the flap, in some situations where the bones are naturally thinly covered, as on the outer side of the forearm, the anterior part of the leg, or just above the ankle-joint, or where the soft parts have been wasted by chronic disease. The flaps should be made by a steady sweeping cut, so that the soft parts may be evenly and smoothly divided. Their length must of course be proportioned to the thickness of the limb; and on this point no positive directions can be given, except that care be taken that they be not cut too long nor too short. If they be cut too long, too much muscle will be left on the stump, and the flap itself is usually bad fashioned and pointed. Should the surgeon feel that he has made this mistake, the wiser plan would be at once to round off the ends of the flaps. Should they have been cut too short, the soft parts must be forcibly retracted, and the bone cleared by circular sweeps of the knife, and sawn as high up as possible.

The flap farthest from the vessels, as that on the outer side of the thigh or arm, should be cut first. In making the inner flap, great care must be taken to wind the point of the knife well round the bone, so as not to transfix and split down the vessels, but to cut them as long as possible. As a general rule, the less loose muscle that is left on a stump, the better: hence, where there is an equal thickness of soft parts round the bone, as in the arm and thigh, the flaps should be cut short, well retracted, and the bone cleared by circular sweeps of the knife as high as necessary. The bone thus lies at the bottom of a conical hollow beyond the angle of junction between the flaps, and there is less chance of a conical stump being left.

When the patient is extremely muscular, and the amputation has to be done in the arm, thigh, or leg, it will be found to be most convenient to have skin-flaps only, made by cutting from without inwards, dissecting up the integuments from the fascia to a sufficient extent, and then making a circular cut through the muscles down to the bone, thus leaving only a skin covering. This is more particularly the case where the amputation is primary for injury, as then the muscles often retract to so great an extent that it is difficult to judge of the proper length at which to cut them. The advantage of this procedure over the ordinary flap or the circular operation is very great under certain circumstances. In both cases, but more especially in flap-operations on stout muscular subjects, a large pad of muscle is apt to be left in the stump. This, which at first sight might appear an advantage, as an additional covering to the bones, is a decided disadvantage, inasmuch as it often projects through the retraction of the skin covering it, and is apt to slough and interfere with the proper union of the flaps. This pad is also disadvantageous

after cicatrization is completed, as at first it forms a soft, flabby, and bulbous end to the stump, instead of a firm hard cicatrix; and eventually it must waste and undergo the fibro-cellular transformation, before the stump is finally consolidated. Hence, a stump that at first appears to be covered by a good cushion of soft pads, will, if these be chiefly muscular, gradually shrink and waste, and may at last become conical. If the limb have been the seat of much and long-continued suppurative action, the muscles do not retract when cut, but hang soft and flaccid, as in a dead body. The flaps, therefore, need not be made so long as in primary amputation for injury. And here, also, too much muscle is disadvantageous, getting between the skin-flaps, and occasioning trouble and delay in the healing of the stump.

Sawing the Bone.—So soon as the incisions have been made through the soft parts, the bones must be cleared for the application of the saw. This is best done, when there is only a single bone, by a firm circular sweep of the knife from heel to point round the under segment of the bone, and then another round the upper surface in the opposite direction. If there be two bones, care must be taken in clearing them not to direct the edge of the knife upwards into the interosseous space higher than the line to which the saw is to be applied, lest any artery be cut high up in this situation, where it is always difficult to secure it, owing to its retraction above the cut end of the membrane.

The bone having been properly cleared, the flaps must be forcibly retracted by an assistant, in order to admit of the proper application of the saw, which should always be made opposite the highest point to which the incision is carried through the soft parts. For the purpose of retraction the assistant's hands are quite sufficient, though some surgeons are still in the habit of using "*retractors*," made of split pieces of linen cloth or of wash-leather. But although "retractors" may not be required for the purpose of drawing back the soft parts, they are of great use in another way; viz., in protecting the muscles from the teeth of the saw and from the bone-dust produced by the action of that instrument: both these conditions—the laceration of the deep muscles by the saw, and the imbedding of particles of bone-dust in their substance—interfering seriously with union by the first intention. In order to saw the bone quickly and steadily, there are several points deserving attention. The first cut should be made so as to form a deep groove to receive the teeth, by pressing the left thumb on the bone, and applying the heel of the saw, held horizontally, along this, by which it is steadied; the instrument must then be drawn fairly and sharply along the whole line of its teeth from heel to point. The groove thus formed receives the edge of the saw; and the bone may then be quickly cut through by long, light, and sweeping movements of the instrument from point to heel, the position being gradually changed from the horizontal to the vertical as progress is made. The surgeon must, with his left hand, support, the part to be removed; and care must be taken not to bear upon this, so as to snap the bone as it is weakened by the action of the saw; nor should it be so much raised as to run the risk of locking the saw. When there are two bones in the limb of equal strength, as in the forearm, they should be cut through at the same time; but in the leg, the fibula, being the weakest, should always be first divided. Should the division be made irregularly, and splinters of bone project, these must be snipped off with cutting-pliers.

Arrest of Hemorrhage.—After the limb has been removed, the first thing to be done is to restrain arterial hemorrhage. This may be effected by ligature, acupressure, or torsion. Of the relative merits of these three methods of treatment I will say nothing here, but must refer the reader to Chapter XII. If ligatures be used, the main and larger arteries must first be tied. For this purpose, fine compressed *whipcord* is the best material. The ends of these ligatures, knotted together, must be left long, so that they may be distinguished. Usually from two to four or six smaller vessels require to be tied, and they should be secured with ordinary ligature-thread; but sometimes, either from the existence of malignant disease in the limb, or when extensive suppurative action has been going on in the limb, the stump is excessively vascular, and a very large number of ligatures may be required. I have, in these circumstances, more than once had occasion to apply between twenty and thirty ligatures to vessels in the arm and thigh. As union always takes place by granulation in such cases, it signifies little how many ligatures are put on, the smaller ones separating early. One half of each ligature should be cut off close to

the knot, and the single threads thus left must be brought out at the lower angle of the wound, through which any discharge that may form may drain away. *Silver* or *iron wire* may be used for the purpose of ligaturing the arteries, with the view of preventing the suppuration that results from the irritation of the ordinary silk or thread ligatures, and thus facilitating union by the first intention. I have employed them in several instances, but have found this inconvenience resulting from their use, that they do not cut through the artery as the thread does, and consequently do not detach themselves, but require to be pulled or twisted off—a procedure likely to be attended by risk of hemorrhage. The practice of cutting the ends of ligatures short, whether hempen or metallic, is most objectionable; for, although the stump may heal over them, they eventually become sources of irritation, and set up suppuration or develop neuralgia.

Acupressure, and torsion of the ends of cut arteries, are often employed instead of the ligature by the advocates of these methods. For a detail of the mode of arresting hemorrhage by these means, I must again refer to Chapter XII.

Free arterial bleeding will sometimes take place from a point in the cut surface of the bone, in consequence of the division of the trunk of the nutritious artery. This kind of hemorrhage is best arrested by pressing a small wooden plug into the bleeding bone. To this a piece of wire should be attached, so that it may be drawn out when loosened by suppuration at the end of a few days.

[A small pellet of previously softened white wax, firmly pressed in, will be found very efficient in checking hemorrhage from the medullary cavity of bone; it is perfectly unirritating, does not absorb fetid discharges, and may remain in the wound for an indefinite length of time without doing any harm.—A.]

The mode of union of the flaps of a stump, the dressings required, and the general management of the part after an amputation, differ in no respect from what takes place in the healing of primary incised wounds.

Sutures may be either of well-waxed silk or of metallic wire. They should be introduced through the lips of the incision at intervals of an inch: care being taken to leave the most dependent angles of the stump open, and to draw out the ligatures through them. In cases of primary amputation for injury, or in any case in which oozing is expected, the sutures should be introduced whilst the patient is under chloroform, and left loose. When this is done, silken sutures must be employed, and wet lint applied between the surfaces and over the outside, the dressing of the wound being deferred for a few hours, until the surfaces are glazed. But in amputations for disease, when patients are in a low and irritable condition, I think it is better to apply the dressings immediately after the performance of the amputation, before the effects of the chloroform are recovered from. In these cases metallic sutures should be employed; they are less irritating, and may be retained longer. Before dressing the stump, it is desirable that all oozing should have ceased, lest a coagulum form between the flaps, and so interfere with union; with this view, a jug or two of cold water may be poured over the face of the stump. The dressings should then be applied. They should be as light and unirritating as possible. The object that we have in view is the union of the flaps as speedily as possible—not only along their edges, but throughout the deeper portion of the stump. Strips of adhesive plaster, about fifteen inches long, should be applied between the points of suture, and the stump bandaged from the upper part of the limb as far as the line of incision, so as to bring together the deeper parts of the wound, more particularly where the bone intervenes between the flaps. A piece of wet lint, kept constantly moist with cold water, should then be laid over the line of incision, the stump comfortably supported on pillows, and the weight of the bedclothes taken off by a cradle. After this, it should be disturbed as little as possible for a few days. The wet lint, which will become soiled by a reddened sero-sanguinolent discharge, must be changed every few hours. Union by the "first intention" can only be expected to take place in certain amputations, and even in them not wholly and entirely. When the bone is very large, as the femur, an angle is apt to be left between the flaps at the apex of the stump, which, by preventing complete coaptation at this point, renders direct union impossible; so also, if a cavity exist in the bone, as the glenoid or cotyloid in amputation at the shoulder and hip, there will necessarily be suppuration. Then, again, muscle will not adhere directly to synovial membrane or to cartilage in disarticulations, and in many cases not even to the cut surfaces of bone. In fact, for all these reasons, independently of any constitutional causes,

complete primary union, or that by the "first intention," is much more rare than is commonly supposed, and is more frequently talked about than seen in amputations. However, whatever portion of the stump unites directly and primarily is so much gained, and no effort should be left untried to secure so desirable a result.

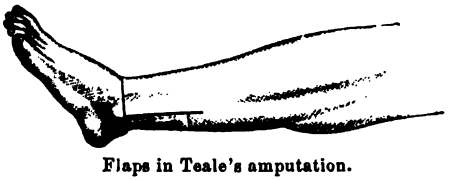
When suppuration sets in, warm-water dressings should be substituted for the cold lint, and every possible attention should be paid to cleanliness by a frequent change of the dressings, more especially in warm weather.

Erysipelas, with a more or less *sloughy condition of the stump*, not unfrequently occurs. In such cases all sutures should be at once taken out, and the strips of plaster either taken off or reduced to two, put on lightly so as merely to afford some degree of support. The stump should be enveloped in soft poultices, and well washed with warm water or disinfecting fluids at each change; great care being taken not to allow matter to be confined, or to loosen the ligatures. The constitutional treatment of the case must be conducted on the principles that will be detailed in the chapter on Erysipelas; but as a general rule, it should be tonic and stimulating, dietetic rather than medicinal. Should secondary hemorrhage occur, it must be treated as will be hereafter described.

When suppuration is subsiding, and cicatrization going on, the bandage may advantageously be brought over the face of the stump. As a general rule, it will be found that a narrow roller will adapt itself better than a broad one. After cicatrization is completed, the patient should be allowed to go about on crutches, but must not wear an artificial limb for several months, until the parts have become firmly consolidated; during the whole of this time the stump should be kept carefully bandaged, and not exposed to injury.

Amputation by the Rectangular Flap.—The late Mr. Teale, of Leeds, for some years practised amputation by a long and a short rectangular flap, with a view of procuring a more useful stump, and in the hope of somewhat diminishing the mortality of the operation. In performing amputation by this method, the long flap is cut from that side of the limb where the parts are generally devoid of large bloodvessels and nerves; whilst the short flap is made to include those structures which are cut across transversely, as shown in the annexed figures from Mr. Teale.

Fig. 4.



Flaps in Teale's amputation.

The long flap is perfectly rectangular; and the rule for its formation given by Mr. Teale is, that its length and breadth should each be equal to the half of the circumference of the limb at the place of amputation. If the circumference be 9 inches, the length and the breadth of the flap should be each 4½ inches.

The short flap, which is always cut so as to contain the chief vessels and nerves, is one-fourth of the length of the long one.

After the bones have been divided in the usual way, and the vessels tied, the long flap is folded over the end of the bone, and attached by sutures, as in the acompanying figure (5), to the short flap.

Fig. 5.

Teale's amputation: stump.

Mr. Teale directs that the stump should be laid on a pillow lightly covered with gauze or linen, and protected from pressure by a cradle; but in the early treatment he says that no dressings are required.

The *results* of amputation by this method were very satisfactory in Mr. Teale's hands; but more abundant evidence is required in order to show whether the mortality of amputations generally is dependent on the particular method adopted, rather than on constitutional causes and external influences that operate equally in all cases.

The rectangular method undoubtedly possesses one very great advantage over the circular or ordinary flap, in giving a soft and thick covering to the ends of the bones, admitting of direct bearing upon them; especially advantageous after the amputation of the thigh or leg, when that direct pressure can scarcely be dispensed with, and when a solid, firm stump admitting of it is of very essential service to the

patient. Mr. Teale advises, however, that the whole pressure be not borne by the stump, but that it be reduced to one-half, the remainder being distributed in the usual way on the upper part of the limb and trunk; thus not only relieving the stump, but securing greater steadiness of gait and firmness of step. In the upper extremity, however, no direct pressure is made upon the end of the stump in the adaptation of artificial limbs; hence, in amputations of the forearm or arm, a thickly covered stump is not so much the object of the surgeon as in the leg and thigh. In the former instances, therefore, the rectangular appears to possess an advantage over the double flap method, so far as the after-utility of the stump is concerned.

But, whilst fully admitting the advantage possessed by the rectangular method in the formation of a well-cushioned stump, especially in the lower extremity, we must not close our eyes to certain disadvantages which appear to me to be inseparable from it. The disadvantage consists in the necessity of sawing the bone at a higher point when one long flap only is made, than when two shorter ones of more equal length are fashioned. Thus, for instance, in an amputation of the thigh for injury or disease of the knee-joint, the long rectangular flap in an adult would require to be about eight inches in length, and the femur must consequently be sawn at least as far as this above the patella; whereas, in the ordinary double-flap amputation, two shorter flaps, each about four inches in length, will be found sufficient to cover in the bone, which may consequently be sawn at a proportionately lower point. Thus the rectangular method contravenes one of the best-established principles in amputation, viz., not to remove the limb at a higher point than is absolutely necessary; and cannot be considered to be advantageous in those cases in which length of stump is essential to the after comfort and utility of the patient.

In many injuries of the limbs, also, requiring amputation, the soft parts are often torn in such a way that a good covering may be got for the stump below the knee or elbow by short double flaps, or even by the circular method, when there would be no possibility of fashioning a long flap from uninjured soft parts below those joints; and the increased risk of high amputation would have to be encountered.

In amputations for malignant disease, also, the long flap, which has to be cut from close proximity to the morbid growth, would run a far greater risk of infiltration than would two shorter ones taken higher up in the limb; the bone in both cases being sawn at the same level.

Should union by the first intention fail, and suppuration set in, in the rectangular amputation, the thick fleshy mass which enters into the conformation of the long flap becomes a source of great inconvenience, bulging out from under the skin, and requiring considerable management in the after-treatment.

Amputation by the Long Flap.—In some amputations, as at the shoulder and hip-joints, owing to the anatomical configuration of the parts, only one flap can be made. And in others, as in the removal of the fingers through a phalangeal articulation, or of the metatarsal bone of the great toe, it is found more convenient to make but one long flap, cutting through the soft parts transversely on the opposite side of the limb. This method has been extended by some surgeons to all amputations, but it appears to me to possess no advantage over the double flap, and to be attended by the same inconvenience as that which accompanies the method last described.

Simultaneous or rapidly Consecutive Amputation of Two Limbs, requiring removal for severe injury or for gangrene, has occasionally been successfully practised, either by two surgeons performing the two amputations at the same time; or by the same surgeon doing first one and then the other, the vessels of the first limb being secured by an assistant, whilst the second limb is being removed. The circulation through both lower extremities may be completely arrested by compressing the aorta by means of Lister's tourniquet. By means of this valuable instrument, I have amputated both thighs in close succession without waiting for the ligature of the arteries in that which was first removed. The object in two simultaneous amputations is to lessen the continuance of shock to the system, by throwing, as it were, that of the two operations into one. In doing this, however, the surgeon must necessarily be guided by the circumstances of the case. If the patient was very greatly depressed, the infliction of so severe an injury as a double amputation might probably extinguish life at once; and, if possible to wait after the removal of the first limb, and before the second was amputated, it might be desirable to do so, until the shock of the first operation had passed off; but if the patient were not

too much depressed, the simultaneous or rather rapidly consecutive double amputation would probably be the safe course.

Stumps.—On examining the *structure of a stump*, after a year or two have elapsed from the time of its formation, it will be found to be composed of a mass of fibro-cellular tissue, the muscular and tendinous structures that enter into its formation having become thus transformed. The ends of the bones will be found to be rounded, and the medullary canal filled up, the vessels being obliterated up to the nearest collateral branch (Fig. 6). The ends of the nerves are thickened, and commonly assume a bulbous appearance (Fig. 7). On examining these rounded or oval tumors, they will be found to be fibro-cellular masses, having nervous fibrillæ thinly scattered throughout.

Fig. 6. Fig. 7.

Artery of stump laid open.

Nerve in a stump.

The proper adaptation of *artificial limbs* is a matter of considerable consequence; and the ingenious mechanical contrivances that are at the present day adapted to stumps, leave little to be desired. The surgeon had better leave the details of these mechanical contrivances to the instrument maker; but he should see that they are made light, consistently with sufficient strength and support, and that the end of the stump is never pressed upon by them. Thus, after amputation of the thigh, the artificial limb should take its bearing point from the lower part of the pelvis and hip. In amputation immediately below the knee, this joint should be bent and received into the socket of the instrument; and, if the amputation be at a lower point than this, and the stump be extended into the artificial limb, its end must be protected from injurious pressure. Even in the case of disarticulation at the ankle-joint, where the soft tissues of the heel are left, pressure can seldom be borne upon the end of the stump.

Morbid Conditions of Stumps. *Necrosis.*—It not unfrequently happens that the end of the bone in a stump *necroses*. More commonly it is the consequence of inflammation (osteo-myelitis) set up in that portion of the shaft which is left in the stump, as the result of which its vitality is lost, and necrosis sets in; or it may occur in consequence of the injury inflicted by the jarring of the saw. This is especially apt to happen in persons of feeble constitution, in whom the limb has, previously to the operation, been the seat of abscess that has denuded the bone or otherwise injured its vitality. In these cases a fistulous opening will be left leading down to the necrosed bone, which usually separates three or four months after the operation in the shape of a complete ring, with irregularly spiked prolongations stretching from its upper part (Fig. 8); after this has been removed, the stump becomes firmly consolidated. The lower part of such a sequestrum is thick and annular, and includes the whole thickness of the bone. It is smooth externally, where it has been covered by the periosteum. About an inch above this it becomes thinner, and is composed of the innermost part of the bone—that which surrounds the medullary canal. Then it is roughened externally, where it has separated from the adjacent healthy bone; and above this it is spiculated and very irregular, becoming gradually thinner. In some cases the spiculated part is very sharp-edged; in others, as in Fig. 8, it is somewhat smoothed by long contact with the pus that has surrounded it.

Fig. 8.

Necrosed end of femur from stump.

Conical or "sugar-loaf" stumps, as they are called, commonly form either in consequence of the flaps having originally been cut too short, or from the bone not having been sawn off sufficiently high above the angle of the flaps; but in other cases they may occur, though the stump has been skilfully fashioned, in consequence of the soft parts, which have been the seat of inflammatory action and suppuration before the amputation, retracting during the granulating process, so as to denude the bone. In such cases as these, great retraction and contraction of the flaps are apt to go on during cicatrization, so that the bone

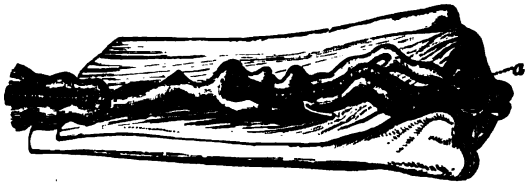
may never be covered at all, but be exposed at the bottom of an irritable ulcer; or, if the soft parts do coalesce, the cicatrix will be unable to support the slightest pressure without becoming ulcerated. In these circumstances, the only remedy consists in laying open the stump, and cutting off about three inches of the bone.

If the stump be too long and projecting, so as constantly to be in the patient's way, there is no remedy but to perform a second amputation higher up. This is especially required in badly fashioned stumps of the leg, where the limb has been removed too far below the knee, so that it projects backwards in an awkward manner, and is constantly liable to accident when the patient uses a wooden pin.

Painful and Spasmodic Stumps.—The nerves in a stump naturally become somewhat expanded and bulbous; and no material inconvenience results from this condition. But it occasionally happens that a distinct tuberose enlargement forms in connection with one of them, and attains the size of a cherry or a walnut; and, this being pressed against the end of the bone, or a nervous twig being implicated in the cicatrix, the stump becomes the seat of intense pain of a neuralgic character, more particularly whenever it is touched. In such circumstances, excision of this bulbous extremity of the nerve, or resection of the stump so as to remove the end of the bone and the whole of the cicatrix, is necessary, and will effect a cure. Besides this form of painful stump, which may happen in the strongest and healthiest subjects, and is entirely dependent on local causes, there is another condition in which the stump becomes not only the seat of intense pain, but usually of convulsive twitchings. This form of painful stump arises from constitutional causes, and most frequently occurs in females, more particularly in those of the hysterical temperament, and who are or have been subject to neuralgic pains elsewhere. In these cases the general cutaneous sensibility of the stump is increased, it is often the seat of convulsive jerkings or twitchings, and the pain is more or less intermittent, being increased under the influence of various emotional and constitutional causes. In such cases, the treatment should be conducted on the general principles that will be fully discussed when we come to speak of neuralgia. No excision of the nerves of the stump, or even amputation higher up, is of any avail; the disease, being constitutional, will certainly return in each successive stump, until at last the shoulder or the hip may be reached without any permanent benefit to the patient.

Aneurismal enlargement of the arteries of a stump is extremely rare. The only case with which I am acquainted is one given to me by Mr. Cadge, in which an aneurismal varix formed in a stump after disarticulation of the ankle-joint (Fig. 9, *a*).

Fig. 9.



Aneurismal varix in a stump.

Strumous or malignant degeneration may occur in a stump, presenting the ordinary characters of these affections met with elsewhere. In the strumous stump, secondary amputation may advantageously be performed; but on the recurrence of malignant disease it is seldom justifiable, as there is probably deposit in internal organs or contamination of the lymphatics.

Fatty degeneration of the muscles of a limb, arising from their disuse, gives rise to a peculiar appearance in the stump. During the amputation, the muscles look like pieces of yellow wax, and are firm; no atrophy, so far as size is concerned, has taken place; the fat being deposited between the muscular fibres, producing atrophy of them by its pressure, and occupying their place, so that the general size of the limb and fulness of the stump are preserved. Union takes place in these circumstances, though somewhat slowly; at least, this occurred in several cases in which I have observed this condition. In one of these I amputated the leg for disease of the foot of nine years' standing, and in another the thigh for disease of the knee of fourteen years' standing.

Mortality after Amputation.—The general causes of death after operations have already been considered; but we must now examine some special points connected with the relative mortality after amputations of different kinds, and the cause of the difference that exists. The principal causes of death after amputation are the influence of shock, the occurrence of secondary hemorrhage, pyæmia, erysipelas, phlebitis, and congestive pneumonia; besides these, hospital gangrene and sloughing

of the stump occasionally carry off the patient. Pyæmia is the most frequent cause of death after amputations, nearly one half of the patients that die perishing from this disease. Mr. Bryant has shown that, at Guy's Hospital, it is fatal in ten per cent. of all amputations, and in forty-two per cent. of fatal cases, and that it is most frequent after amputations through limbs, the tissues of which are in a normal condition, and where a large surface of healthy bone is exposed, as in primary amputations, and in the removal of limbs for tumors, talipes, anchylosis, &c. It is not so common after amputations performed for chronic joint-disease or secondarily after injuries.

The circumstances which more specially influence the general result of amputations, as well as the particular cause of death after the operation, may be divided into two classes: α. Those that have reference to the general constitutional condition of the patient. β. Those that are connected with the operation itself.

α. To the first class may be referred, 1, *Age;* 2, *General Health;* and 3, *Hygienic Conditions.*

1. *Age* exercises a material influence on the result of amputations. As a general rule it may be stated that, the younger the patient, the greater the likelihood of a successful result. At early periods of life, also, there is a great exemption from low secondary diseases of the erysipelatous type; and, if death occur, it is usually from exhaustion or intercurrent visceral mischief.

2. The *general health* of the patient previously to the operation exercises necessarily a most powerful influence on the chances of recovery. The state of the kidneys, more especially, is of great importance in this respect; for no condition tends more certainly to a fatal termination, than a chronically diseased state of those organs. The results of amputation are also necessarily widely different, according as the operation is practised on the healthy inhabitant of a country district, or on the cachectic and debilitated denizen of a large town. The causes of death also differ in these cases. In the country, hemorrhage or acute inflammation; in towns, exhaustion, erysipelatous diseases, and pyæmia, commonly lead to the fatal result.

3. The *hygienic conditions* that surround the patient after the operation exercise perhaps an equally important influence, not only on the rate of mortality, but on the cause of death. Exposure to an impure atmosphere, want or bad quality of food after an amputation, lessen materially the prospect of recovery, by disposing the patient to the worst forms of erysipelas, pyæmia, and hospital gangrene.

[Dr. Addinell Hewson has investigated the relation between the barometric condition of the atmosphere and the mortality after amputations. He says: "We got a mortality when operations were performed with the barometer ascending of not quite 11 per cent.; of over 20 per cent. with it stationary; and over 28 per cent. with it descending. Of the fatal cases the average length of time which the patient survived the operation was only 7 days when the barometer was ascending, and 13 when it was descending; and of the cases which died within 3 days, over 75 per cent. were when the barometer was ascending. Surely these figures need no commentary as to how well they sustain the idea that the results of operations are materially influenced by the weather, and that the risks from shock and fever are increased by opposite conditions." (*Penna. Hosp. Reports*, vol. ii. p. 34.)—A.]

β. The circumstances connected with the operation itself that influence materially its result, are, 1. The *Seat* of the amputation. 2. The *Structure of the Bone* sawn. 3. Whether the operation is done for *Injury* or *Disease.* 4. If for disease, the *Nature* of the affection. 5. If for injury, the *Time* that has elapsed before the limb is removed.

1. With regard to the influence of the *seat* of amputation on the result of the operation, it may be stated as a general rule, that the risk is greater in proportion as the size of the part that is amputated increases, and as the line of amputation approaches the trunk; in fact, the nearer it is to the trunk, the greater is the danger. In the larger limbs, more especially in the thigh, every additional inch that is removed appears to make a difference in this respect. Thus, in our army in the Crimea, of 178 amputations of the thigh 44 were in the upper third, and of these 38, or 86 per cent. proved fatal; 68 were in the middle third, and of these 41, or 60 per cent. died; whilst in the lower third the mortality out of 66 cases was 37, or 56 per cent. It needs no formal argument to show that the amputation of the toe or of the foot is less hazardous than that of the leg or of the thigh. The statistics

collected by Malgaigne, of amputations of all kinds in the Parisian hospitals, exhibit clearly this increase in the ratio of mortality as the operation approaches the trunk. Thus, in 26 cases of amputation of one of the smaller toes, there was one death; in 46 cases of amputation of the great toe there were 7 deaths, or 15 per cent.; of 38 partial amputations of the foot 9 proved fatal, or nearly 24 per cent.; of 192 cases of amputation of the leg 106 died, or about 55 per cent.; and in 201 amputations of the thigh there were 126 deaths, or 62 per cent.

In the British army in the Crimea the percentages of death were, after amputation of the forearm, 7; of the upper arm, 19; of the shoulder-joint, 35; of the foot, 16; of the leg, 37; of the thigh, 64; and of the hip, 100; figures most creditable to the skill of the surgeons employed, but showing the progressive tendency to increase with the size of the limb removed.

In the war of the American rebellion the percentage of mortality was as follows, showing markedly how rapidly it runs up in accordance with the size of the part removed: fingers and hand, 1.5; wrist, 5.5; forearm, 16.5; arm, 21; shoulder, 39; partial of foot, 9; ankle-joint, 13; leg, 26; knee, 55; thigh, 64; hip, 85.

Not only do the size of the part removed, and its proximity to the trunk, influence materially the general mortality after amputation; but these conditions also influence the particular cause of death. Thus after the smaller amputations, as of a toe, for instance, death occurs only in unhealthy states of the constitution, from the occurrence of erysipelas, or of some of the various forms of diffuse inflammation. Death after the larger amputations more frequently results from causes connected with the operation itself, as, for instance, secondary hemorrhage, shock, or exhaustion by the abstraction of the large quantity of blood contained in the limb, as well as by that lost during the operation. After the removal of the whole of a limb, as in the case of amputation at the hip-joint, it is possible that the cause suggested by Mr. Cox, viz., the removal of a limb in which the blood undergoes changes of importance to the rest of the economy, may materially affect the result.

2. The *part of the bone* that is sawn through may influence the result. Amputations through the cancellous ends of long bones are less dangerous, in one respect, than those through their shafts, in consequence of the medullary canal not being opened when the section is made near the articular end; so that the liability of diffuse suppuration of this cavity, and of consecutive phlebitis and pyæmia, is avoided.

3. The mortality resulting from amputations is perhaps more directly influenced by whether the operation is done for *injury* or *disease*, than by any other cause, being far greater in corresponding limbs after injury than disease. In the following table may be seen the results of 274 cases of amputation performed at University College Hospital up to May, 1868.

RESULTS OF AMPUTATIONS IN UNIVERSITY COLLEGE HOSPITAL.

Amputations for Injury.

Seat of amputation.	Cases.	Recoveries.	Per cent.	Deaths.	Per cent.
Thigh	35	13	37.1	22	62.8
Leg and foot	38	28	73.7	10	26.3
Shoulder and arm	11	7	63.6	4	36.3
Forearm	8	8	100.0	0	0
Total	92	56	60.9	36	39.1

Amputations for Disease.

Seat of amputation.	Cases.	Recoveries.	Per cent.	Deaths.	Per cent.
Thigh	75	62	82.7	13	17.3
Leg and foot	67	57	85.0	10	14.9
Shoulder and arm	21	15	71.4	6	28.5
Forearm	19	18	94.7	1	5.2
Total	182	152	83.5	30	16.5

Of these amputations, 66 occurred in the hospital up to 1841, and are reported by Mr. Potter in a paper published in the *Medico-Chirurgical Transactions* for that year. They were performed by the several surgeons of the Institution at that time. Of the remaining 208, 41 were performed by Mr. Liston, between 1841 and his death in 1847; 5 by his immediate successors; and 162 by the author.

Malgaigne's statistics from the Parisan hospitals illustrate this matter in an equally clear point of view, as will be seen in the following tables.

Seat.	*Injury.*			*Disease.*		
	Cases.	Deaths.	Per cent.	Cases.	Deaths.	Per cent.
Thigh	46	34	74.	153	92	60
Leg	79	50	63.3	112	55	49
Foot	9	6	66.6	29	3	10.3
Arm	30	17	56.6	61	4	6.5

The following table gives the results of cases occurring in the London and provincial hospitals for three years, as published in the *Medical Times*.

Seat.	*Injury.*			*Disease.*		
	Cases.	Deaths.	Per cent.	Cases.	Deaths.	Per cent.
Thigh	90	55	61	303	71	23.4
Leg	110	44	40	137	35	25.5

The *shock* inflicted by the injury, with its subsequent evils, appears to be one of the principal reasons of the greater frequency of the mortality after amputations for injury than after those for disease. After amputation for injury, also, there is a greater liability to the occurrence of gangrene of the stump, and pyæmia and its secondary effects, than in the case of the removal of a limb for disease; in which the principal causes of death usually appear to be exhaustion, and the supervention of disease of the lungs. In amputation in cases of disease, it will be found that those patients do best in whom the disease is most chronic. This is especially observable in cases of disease of bones and of the joints.

4. The *nature of the disease* for which the amputation is performed influences its mortality. Thus, amputations for malignant disease are more fatal than those for caries of bone or diseased joints. In cases of diseased joint, there is a greater tendency to recover when the affection is of a simple than when it is of a tuberculous nature. When suppurative disorganization of a joint is very acute, amputation, more particularly if the affected articulation be of large size, as the knee, is attended by very unfavorable results. The tendency to pyæmia is especially strong in such cases, the blood being loaded with effete materials, the products of the inflammatory action, which are specially apt to run into suppuration, both in it and in the tissues generally. But when the disease has once become chronic, the precise period at which the amputation is performed exercises but little influence on the mortality, provided it be not deferred to too late a stage, when the patient's constitution is worn out by hectic.

Amputations of expediency—those performed for the convenience of the patient, as in cases of talipes or anchylosis, but not necessary, so far as life is concerned—are especially fatal. Mr. Bryant has shown that, at Guy's Hospital, death has followed in 40 per cent. of these amputations of the lower extremity.

5. In amputation in cases of injury an important question has to be determined, viz., the influence exercised by the *time* that has elapsed from the infliction of the injury to the performance of the amputation. Not only the rate of mortality, but the conditions that immediately occasion the fatal event are influenced by the period at which the operation is performed.

Amputations for injury are commonly divided by surgeons into *primary* and *secondary*; the *primary* being those that are performed during the first twenty-four

Primary Amputations.				*Secondary Amputations.*			
	Cases.	Deaths.			Cases.	Deaths.	
Thigh . . .	13	8	James.	Thigh . . .	15	5	James.
	5	5	South.		18	15	Steele.
	11	11	Laurie.		24	16	Laurie.
	32	21	Steele.		2	0	Hussey.
	6	5	Hussey.		14	5	Callender.
	19	6	Callender.				
Leg	18	7	James.	Leg	5	1	James.
	9	2	South.		19	13	Steele.
	22	15	Laurie.		5	3	Laurie.
	53	22	Steele.		2	0	Hussey.
	13	0	Hussey.		14	5	Callender.
	27	8	Callender.				
Shoulder and arm	19	3	James.	Shoulder and arm	4	1	James.
	6	0	South.		16	9	Steele.
	26	13	Laurie.		14	7	Laurie.
	49	15	Steele.		1	1	Hussey.
	16	3	Hussey.		7	3	Callender.
	25	1	Callender.				
Forearm . . .	18	0	James.	Forearm . .	1	0	Hussey.
	1	0	South.				
	15	0	Laurie.				
	35	1	Steele.				
	15	1	Hussey.		2	0	Callender.
	22	0	Callender.				

RESULTS OF PRIMARY AND SECONDARY AMPUTATIONS IN CASES OF INJURY, AT UNIVERSITY COLLEGE HOSPITAL.

Seat.	*Primary.*		*Secondary.*	
	Cases.	Deaths.	Cases.	Deaths.
Thigh	14	8	21	14
Leg and foot	22	8	16	3
Shoulder and arm	6	2	5	2
Forearm	6	0	1	0
Total	48	18	43	19

or thirty hours, before any inflammatory action in the part injured has taken place. By *secondary* amputations many surgeons mean those operations that are practised after the first twenty-four hours; whilst others again restrict the term to those that are done after suppuration has set up in the limb, calling those amputations *intermediate* that are performed between these two periods, viz., from the twenty-fourth hour to the occurrence of suppuration, and which consequently occupy a very extensive range. I think, however, that this distinction is a somewhat trivial one, and not very easily applied in practice; and it is better to include under the term *secondary* all amputations performed after inflammatory action has been set up in the injured part. In civil practice, the mortality after primary amputations, as will be seen by the preceding table, somewhat exceeds that following secondary operations. It is more especially primary amputations of the lower extremities, and particularly those of the thigh, that are attended by very fatal results. Of the 46 cases of primary amputation of the thigh, recorded by Malgaigne, 34 perished. And of 24 cases recorded by South, Laurie, and Peacock, as occurring at St. Thomas's Hospital, the Glasgow Infirmary and the Edinburgh Infirmary, every one proved fatal. This similarity of result, occurring in different institutions, shows clearly that the operation is one of the most fatal in surgery, and that the great

mortality attending it is inherent to it, and not dependent upon local or accidental circumstances. This danger of amputation of the thigh for injury is increased in proportion as the limb is severed high up. It is least in those cases in which the operation is done for injury of the leg or knee-joint, and greatest when it is performed for compound fracture of the femur, recovery from which is rare indeed.

In military practice the case is different; secondary amputations, with the exception of those at the hip-joint, being by far more fatal than primary. This has been the experience of army surgeons from the time of Faure, Larrey, and the Peninsular officers, to those of the late Crimean campaign. Thus, Faure saved only 30 out of 300 secondary amputations, whilst Larrey saved three-fourths of those in which he amputated primarily. In the Peninsular war, the mortality after secondary amputation of the upper extremity was twelve times, and after secondary amputation of the lower limb, three times, as great as after primary amputation of these parts. In the British army in the Crimea, from the 1st of April to the close of the war, the relative rate of mortality per cent., after primary and secondary amputations, was as follows:—

After *primary* amputations at the shoulder, 27; of the arm, 17; of the forearm, 3; of the thigh, 62; of the leg, 30; and of the foot, 17.

After *secondary* amputations the deaths per cent. were—at the shoulder, 66; of the arm, 31; of the forearm, 28; of the thigh, 80; and of the leg, 76. Or, for the upper extremity, the whole rate of deaths after primary was 15, against 41 after secondary amputations; whilst, for the lower extremity, excluding the foot, it was 46 for the primary, against 78 per cent. for the secondary.

To what is this difference between the results of primary and secondary amputations in civil and military practice owing? Why are the results of amputations reversed in civil and military practice? Why are primary amputations more fatal in civil, and secondary amputations in military practice? I think we may explain this difference in respect to primary amputations, partly by the circumstances under which the injury of the limb has been received, and partly by the difference in the nature of the accident. As has already been stated, the shock to the system is the main cause of death after primary amputations, and this is felt less severely by the soldier than by the civilian. A soldier struck in the heat of action, when his spirits are raised, and his courage is high, treats his wound almost with indifference, or looks upon it, perhaps, as a glorious accident of his profession; whilst the civilian, whose limb is crushed by the wheel of a carriage, or the fall of a scaffold, is not only mentally unprepared for such an accident, but is depressed by the magnitude of the calamity that has unexpectedly overtaken him, in which he sees, perhaps, his own ruin and that of his family. Hence the depressing influence of the shock of the injury is seriously increased by the mental distress accompanying it, and the chances of recovery are proportionately diminished. In addition to this, amputations are not uncommonly very properly done on the field, in cases in which an attempt would be made in civil practice to save the limb; and, as the injuries are frequently produced by musket-shot, there is less mangling of the limb, and consequent shock to the system, than when a member is crushed by those accidents in mines, on railways, and by wagons, for which primary amputation is commonly required in civil life.

In secondary amputations the influence of shock is no longer felt, but the chief danger arises from the occurrence of pyæmia, gangrene, diffuse inflammation, secondary hemorrhage, and all those morbid conditions that are apt to be induced by defective hygienic circumstances; and in these respects the civilian is more favorably situated than the soldier. If an injured limb be not removed on the field, the soldier is often conveyed to a crowded hospital, necessarily overfilled with wounded comrades, and rife with pestilential influences, where, if amputation be performed, he has little prospect of escaping infection. The civilian, on the other hand, who is struck down by accident, is placed in a state of cleanliness and comfort—probably greater than he has ever before experienced, can be successfully guarded against all noxious influences, and consequently has the best possible chance of recovery.

As has already been observed, not only does the *rate* of mortality differ in primary and secondary amputations, but also the *cause* of death. Primary amputations are most frequently fatal from shock, hemorrhage, and exhaustion, although death from pyæmia and secondary diseases of a low type is by no means rare in these cases. Secondary amputations for injury most commonly carry off the patient by the super-

vention of diseases of a low type. Amongst these secondary affections that are, according to my observation at the University College Hospital, of most frequent occurrence, gangrene of the stump stands in the first place, especially after traumatic amputation of the thigh, and more particularly if the limb have been in a similar condition before the amputation. Then, again, erysipelas, phlebitis with pyæmia, secondary hemorrhage, and some of the low forms of visceral inflammation or congestion, as pneumonia, pleurisy, and diarrhœa, often produce death. Pyæmia, complicated by congestive and suppurative pneumonia, is the most frequent cause of death after secondary amputation of the leg and arm. Secondary hemorrhage to such an extent as to prove fatal is of very rare occurrence; when it happens, it is usually associated with some diseased state of the blood interfering with the formation of a plastic plug in the artery.

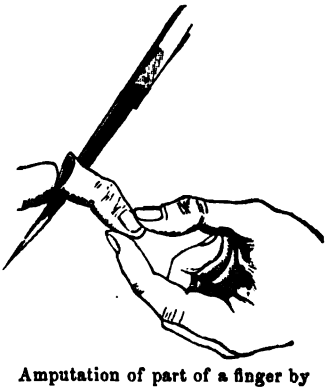
The treatment of the various conditions that prove fatal after amputations will be fully discussed in another part of the work.

CHAPTER III.

SPECIAL AMPUTATIONS.

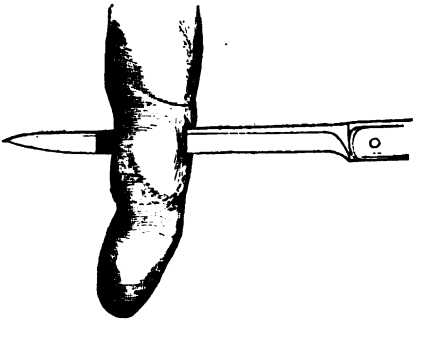
Amputations of the Hand.—The *fingers* not unfrequently require amputation for injury or disease, more especially as the result of bad whitlow. In many cases the ungual phalanx requires removal, having become necrosed. This may usually most readily be done without amputation, by making an incision through the pulp of the finger, and then extracting the diseased bone, thus saving the nail and pulp, which will form an excellent end to the finger, in which, if the operation be done in early childhood, a new and movable phalanx may form. Yet, in other cases amputation will be required. This may either be done by cutting into the joint from its dorsal aspect with a narrow-bladed bistoury, running across it lightly, touching the lateral ligaments, and making the flap from the palmar aspect (Fig. 10); or the flap may conveniently be made from the palmar surface by transfixion, and then cutting across the joint (Fig. 11).[1] In doing this, care must be taken not

Fig. 10.



Amputation of part of a finger by cutting from above.

Fig. 11.



Amputation of part of a finger by transfixion.

to cut too far backwards, and to mistake the depression above the head of the second phalanx for the articulation, which would lead to a little embarrassment. Some little difficulty is occasionally experienced in finding the joint, and surgeons have endeavored to be guided to it by attention to the folds in the in-

[1] For the Conservative Surgery of the Hand, *vide* Chapter XLVIII.

tegument covering it; but in these there is no consistency, and no correlation exists between the joint and the folds in the skin over it. When the amputation is performed from the dorsal aspect, the finger should be flexed, when the joint will be found immediately under the apex of the triangle formed by the phalanges. In operating from the palmar aspect, the finger should be forcibly extended as soon as the flap is made, when, if the knife be applied to the lateral ligaments, the synovial surface will show itself.

Fig. 12.

Amputation above metacarpo-phalangeal joint.

Amputation is performed between the proximal and second phalanges in the same way; but, as a general rule, it should not be done here; because, as no flexor tendon is attached to the proximal phalanx, it is apt to remain permanently extended, and a good deal in the patient's way. In the case of the index finger, however, it will be better to leave the proximal phalanx, the stump of which forms an useful opponent to the thumb.

Amputation is frequently required at the *metacarpo-phalangeal articulations*. Here it may be done in two ways: either by lateral flaps, or by the oval method. If by *lateral flaps*, the adjoining fingers should be well separated from the one about to be removed, by an assistant who grasps the hand, so as to put the integument on the dorsum upon the stretch. The point of a bistoury should then be entered about three-quarters of an inch above the head of the metacarpal bone; it is then carried forwards to a point opposite the interdigital web, drawn across the side of the finger, and then carried a little way into the palm. The same process is performed upon the opposite side, the flaps are dissected down by a few touches of the knife, the extensor tendon is divided, the joint opened, and disarticulation performed. The *oval method*, which I think is the best, as it does not wound the palm, consists in entering the bistoury at the same point as in the last case, carrying it as far as the web, drawing it across the palmar aspect of the finger, and then obliquely backwards to join the starting-point of the incision. By a few touches of the point of the knife the oval flap is turned back, and the articulation opened. As a general rule it is better to remove the head of the metacarpal bone, together with the finger; as otherwise a wide gap will be left in the situation of the finger that has been amputated, and much deformity of the hand result. This may be done by cutting the metacarpal bone across beyond its head with bone-forceps in a transverse direction, if it be either the middle or ring finger that is removed (Fig. 12). If it be the index or little finger, the bone should be cut obliquely from without inwards, so as to shape it to the tapering form of the hand (Fig. 13). If it be cut directly across, an ugly and inconvenient square protuberance, liable to constant injury, will be left. When, however, the patient's employment is one in which great strength and breadth of hand are required, and where appearance is of little consequence, the head of the bone may advantageously remain.

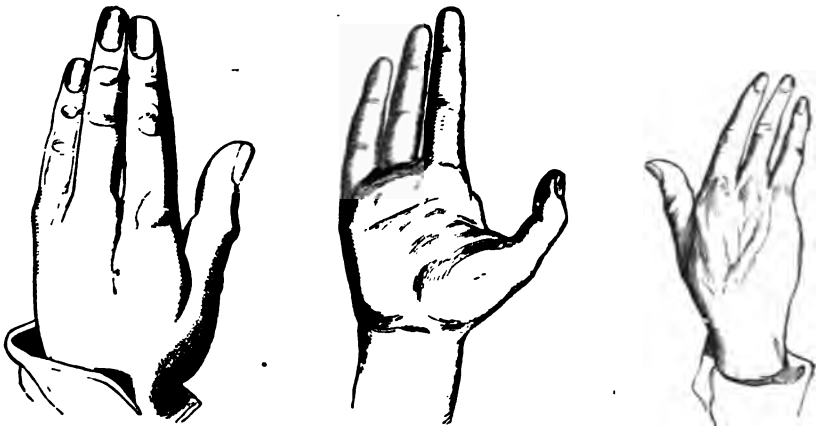
Fig. 13.

Amputation of index finger.

The after-treatment of these cases is extremely simple. The hand should be put

upon a splint, the wound covered with a piece of water-dressing, and the ends of the fingers, with small pieces of lint interposed, tied together by means of a tape,

Fig. 14. Fig. 15. Fig. 16.



Results of amputation above metacarpo-phalangeal articulation.

care being taken, however, that they do not overlap. The shaft of the metacarpal bone that is left will gradually atrophy, and thus a very taper and shapely hand eventually be left (Figs. 14, 15, and 16).

In disease or injury of the *thumb* as little as possible should be removed by amputation; for, if even but a very short stump of the metacarpal bone be left, it will serve as an useful opponent for the other fingers. When the whole thumb requires amputation, it may most conveniently be removed by Liston's method. The mode of proceeding must vary according to the side operated on. When the *left* thumb requires amputation, the point of a long narrow bistoury should be introduced well on the palmar aspect of the carpo-metacarpal articulation, carried over this, which it opens (Fig. 17), and the dorsum of the hand as far as the web of the index finger; the point of the knife should then be pushed downwards through the ball of the thumb, transfixing this and issuing where the incision commenced. It is next made to cut outwards, keeping close to the metacarpal bone, which is readily

Fig. 17. Fig. 18. Fig. 19.

Amputation of the left thumb.

Amputation of the right thumb.

Result of amputation of the thumb.

twisted out, the remaining attachment being separated by a few touches of the knife. An oval incision will be left, which comes together closely by a narrow line

of cicatrix. In amputating the *right* thumb, it will be necessary for the surgeon, if he adopt the method just described, either to use his left hand, or to cross his hands in an awkward manner. In order to avoid doing this, he may reverse the steps of the operation with advantage; first transfixing the ball, and making the anterior flap, then cutting over the dorsum, opening the joint, and turning out the bone (Fig. 18). Fig. 19 shows the hand after amputation of the thumb.

The *metacarpal bones*, with or without the fingers supported by them, occasionally require removal for disease or injury. For these operations, which are not of a very regular kind, it is difficult to lay down definite rules; in performing them, care should be taken to make good square flaps of sufficient size, but to avoid cutting into the palm if possible. It is well not to disarticulate the lower end of the bone, so as to open the wrist-joint, but rather to cut it off with bone-forceps a little above this. In injuries from the explosion of powder-flasks or gun-barrels, when the hand is much shattered, it is of great consequence to avoid cutting up the palm to too great an extent; and it is well in these cases to save a finger if possible, which will be of more use to the patient than any artificial limb, however ingeniously constructed (Figs. 20 and 21). When only one finger is left, as the index or little finger, with the thumb, in cases of partial amputation of the hand after injury or for disease, the digit that remains not only becomes more mobile than formerly, but greatly increased in size and much stronger, so that its utility becomes materially augmented.

Fig. 20.

Hand after amputation of metacarpal bones and first two fingers.

The mortality after amputation of the fingers and metacarpal bones is very trifling. Should death unfortunately occur after such a slight operation, it would probably be by the accidental occurrence of some general disease, such as erysipelas, pyæmia, or tetanus, to which every wound renders a patient liable.

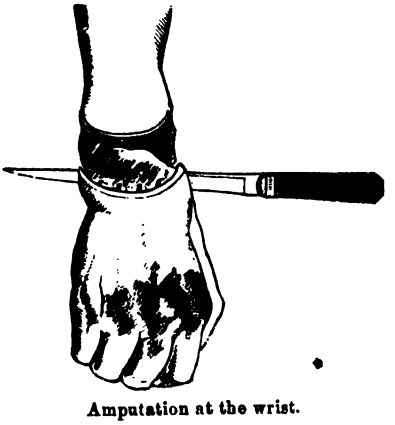
Amputation at the wrist is not very often required. In performing disarticulation at this joint, its peculiar shape with the convexity looking upwards must be born in mind. The integuments being well retracted, an arched incision should be made from one styloid process to the other, across the back of the joint, with its convexity looking forwards (Fig. 22). The articulation having been opened and the lateral ligaments divided, the knife is carried forwards so as to make a well-rounded flap from the palmar surface; in doing this care must be taken not to cut against the pisiform bone, which projects a good deal beyond the other carpal bones.

Fig. 21.

Hand after removal of metacarpal bones and three fingers, leaving thumb and little finger.

Amputations of the Arm.—*Amputation of the forearm* is not unfrequently required for disease or injury of the wrist or hand. In performing this operation, as long a stump should be left as possible, so as to give the patient more power over any artificial limb that may be fitted to it. The flaps should be about a couple of inches in length, and well rounded, the hand being placed in a mid-state between pronation and supination. The dorsal flap is best made by cutting from without inwards; the line of incision commencing just at the palmar aspect of the under part of the ulna, being carried forwards for a little distance parallel to this bone, and then across the back of the arm in a slightly curved manner, until it

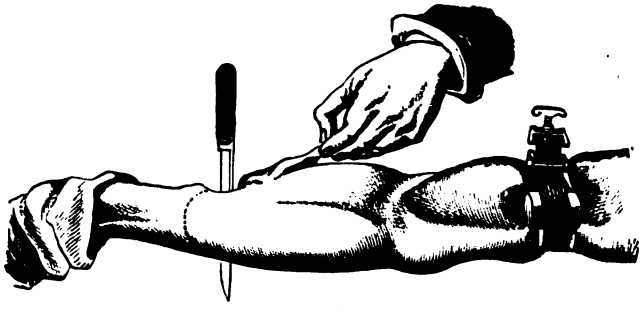
Fig. 22.



Amputation at the wrist.

reaches the palmar aspect of the radius; it must then pass along this until it reaches a point opposite to that at which it commenced, and the flap thus made must be dissected back. The palmar flap is next made by transfixion (Fig. 23.) As soon as it is cut, the bones are cleared by a couple of sweeps of the knife, and the interosseous membrane is divided; they are then sawn together. The vessels are cut long at the end and on each side of the palmar flap.

Fig. 23.

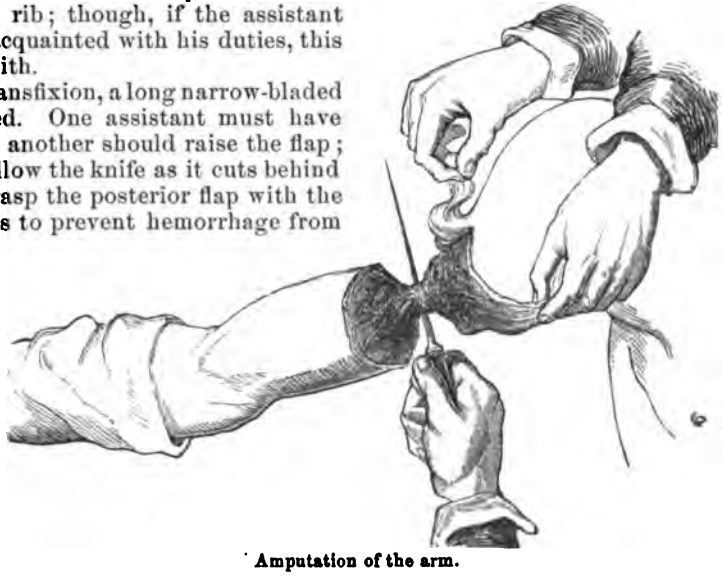


Amputation of the forearm.

Amputation of the arm is most readily performed by lateral flaps made by transfixion from before backwards; the bone is then well cleared by a couple of sweeps of the knife, and sawn across. In clearing the bone, care must be taken fairly to divide the musculo-spiral nerve by a firm sweep of the knife round the back of the bone (Fig. 24), if the amputation be performed in that part of the arm where this nerve winds round the humerus. If the limb be very muscular, skin-flaps and circular section of the muscles will probably give the best result.

Amputation at the Shoulder-joint may be required for injury of the arm or for disease of the humerus; in the first case it is best performed by transfixion; in the other, by cutting from without inwards. The subclavian artery should be compressed as it passes over the first rib; though, if the assistant be steady and well acquainted with his duties, this may be dispensed with.

Fig. 24.

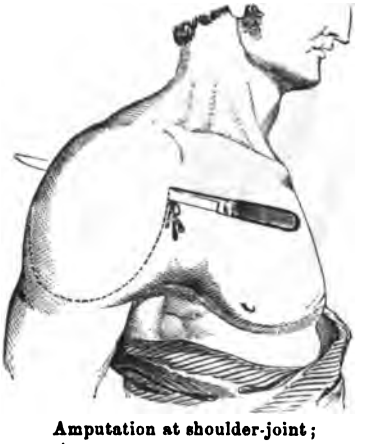


Amputation of the arm.

In operating by transfixion, a long narrow-bladed knife should be used. One assistant must have charge of the limb; another should raise the flap; and a third must follow the knife as it cuts behind the humerus, and grasp the posterior flap with the axillary artery, so as to prevent hemorrhage from this vessel. An assistant holding the arm away from the body, so as to relax the deltoid somewhat, the knife, instead of being entered by a puncture, should make a small cross-cut, about an inch in extent, at the joint at which transfixion is to be practised, so as to prevent that jagging of the integuments by the heel of the instrument which would otherwise occur. If the operation be on the *right* side, the surgeon stands before the patient, and the point of the knife should be entered about an inch in front of the acromion (Fig. 25); and being carried directly across the joint and capsule, should pass out at the posterior border of the axilla. If on the *left* side, the surgeon stands behind, and the point of the knife must be entered well behind

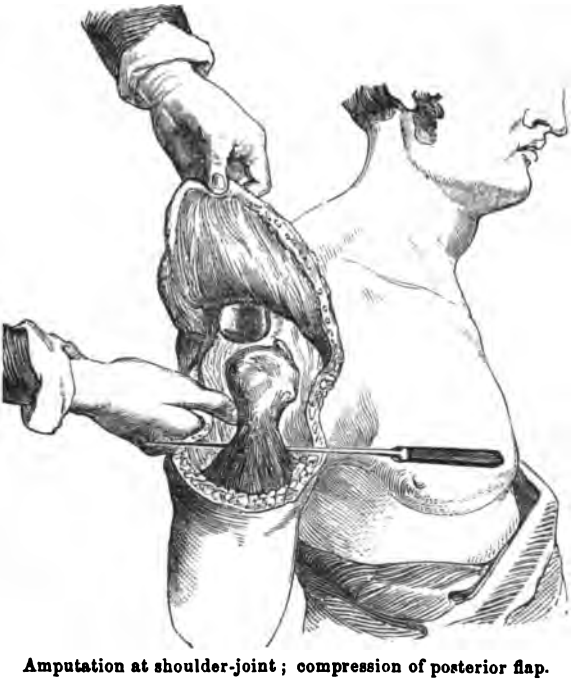
the spine of the scapula, at the posterior border of the axilla, carried across the anterior aspect of the joint, and brought out to the inner side of the coracoid process. In either case, the large flap containing the deltoid muscle must then be cut by a sweep of the knife downwards, and, as soon as made, raised by another assistant. The heel of the knife is now to be laid on the head of the bone, the capsule of the joint cut across, and the attachments of the muscles to the tuberosity divided. In order to facilitate this part of the operation, it is generally recommended that the arm should be carried forcibly inwards across the chest. This may readily be done in the dissecting-room, or in actual practice where the limb is removed for disease of the humerus, the limb being entire; but in the case of comminuted fracture of the humerus, with extensive laceration of soft parts, it is useless to attempt this manœuvre. In cases of this kind, the head and upper end of the humerus being broken off from the shaft, the lever-like action of the bone cannot be put in force, and it is sometimes not such an easy matter as might at first appear, to detach its head from the glenoid cavity. In order to do this, I have in cases of comminuted fracture of the humerus, in which I was amputating at the shoulder-joint, found it necessary, after opening the capsule, to seize hold of the upper fragment and to draw it forcibly downwards and inwards by inserting the fingers between the head and the glenoid cavity, in order to divide the muscles inserted into it. After the head of the bone has been turned out of the glenoid cavity, the knife must be passed behind it, and carried down for a distance of about three inches close to the bone at its inner side. The surgeon then cuts across the soft parts, so as to form the posterior flap. In doing this, the assistant, to whom this part is intrusted, must follow the knife with his hands, grasping firmly the whole thickness of the posterior flap, so as to compress the axillary artery, and thus prevent the occurrence of hemorrhage (Fig. 26). The surgeon should not cut the flap across until the assistant tells him that he holds the vessel firmly, and then he must be cautious not to injure his assistant's fingers. The artery will be found to be cut long in the middle of the posterior flap, and a few smaller branches may be required to be tied at its inner angle and in the deltoid. The stump, after it is healed, will present the appearance shown in Fig. 27.

Fig. 25.



Amputation at shoulder-joint; transfixion.

Fig. 26.



Amputation at shoulder-joint; compression of posterior flap.

In those cases in which this operation requires to be performed for disease, especially for tumor of the humerus, by which the soft parts are thinned or condensed, it may very conveniently be done by making the anterior flap by dissecting it up from without inwards, using of course for this purpose a short knife; a broad bistoury is most convenient. The joint is then opened,

Fig. 27.

Stump after amputation at shoulder-joint.

and the posterior flap formed in the usual way. In this way I have easily performed amputation at the shoulder-joint for large tumors of the head of the humerus.

General Results of Amputations of the Upper Limb.—Amputations of the upper extremity, even for injury, are extremely successful. In the Crimea, amputations of the forearm were fatal in the ratio of 7, and those of the arm of 19 per cent. At Guy's Hospital, Mr. Bryant states that traumatic amputations of the forearm were fatal in the ratio of 16, and those of the upper arm of 22 per cent. At University College, in Mr. Liston's and my practice, of 11 traumatic amputations of the upper arm, there were 4 deaths; whilst of 8 in which the forearm was removed, all recovered. The cause of death is usually pyæmia, erysipelas, or congestive pneumonia.

Amputations of the forearm and arm for disease, more particularly for strumous affections of the bones and joints, are amongst the most successful operations in surgery. When they are done for malignant disease, the risk is greater.

Amputation at the shoulder-joint for injury, although necessarily more fatal, is very successful for so severe a procedure. In the Crimea, the mortality amounted to 35 per cent. At University College I have done it four times, with one fatal result. When this operation proves fatal, the patient usually sinks from exhaustion, or is carried off by the extension of erysipelas or gangrene to the stump and trunk.

Fig. 28.

Incision in amputation of a toe.

Amputation at the shoulder-joint for disease of the humerus is a very successful procedure, considering the size of the part removed, and its proximity to the trunk.

Amputations of the Foot.—The *phalanges of the toes* seldom require amputation; when they do, they may be removed in the same way as the corresponding parts in the hand—by the formation of a flap on the plantar surface, either by cutting from above downwards, or by transfixion.

In removing a bone at the *metatarso-phalangeal articulation*, the oval method should always be practised, so that the sole of the foot may not be cut into. In doing this it must be remembered that the articulation is situated considerably above the web of the toes, and the incision must therefore be commenced proportionately far backwards (Fig. 28). As a general rule, it will be found that the articulation is about the same distance above the web as the point of the toe is below it.

The *metatarsal bone of the great toe* occasionally requires removal in whole or in part. If the disease be limited to the anterior part, the shaft of the bone should be cut across with a pair of bone-nippers, and its head left; for, as this gives insertion to the peroneus longus, its removal will materially weaken the foot. The whole of the bone may be readily removed in the following way: the point of a strong broad bistoury should be entered on the dorsum of the foot over the interspace between the first and second metatarsal bones, as far back as possible; it should then be carried forwards upon the ball of the great toe, to a point opposite to the web between the toes and thence made to sink into the sole of the foot in a line parallel with the outer margin of the bone; the flap thus formed should be dissected back, its planter aspect being kept as thick and fleshy as possible (Fig. 29). The surgeon next passes the knife between the first and second metatarsal bones, and cuts directly forwards through the centre of the angle between the great and the second toes. In doing this, care must be taken that the edge of the knife is not directed too much towards the metatarsal bone of the great toe, lest it hitch against one of the sesamoid bones. The surgeon next seizes the extremity of the toe, and, pressing it well inwards, passes the point of the bistoury deeply into the angle of the wound (Fig. 29), where, by the division of some tendinous and ligamentous

fibres that constitute the key of the joint, he opens the articulation and detaches the bone by lightly touching its ligamentous attachments. By keeping the edge of the knife well against the side of the bone, he may avoid wounding the dorsal artery of the foot, the bleeding from which would be troublesome. When the bone is to be partially removed, the operation must be performed in the same way; the incisions, however, not being carried so far backwards.

Fig. 29.

Removal of metatarsal bone of great toe; flap formed; joint being opened.

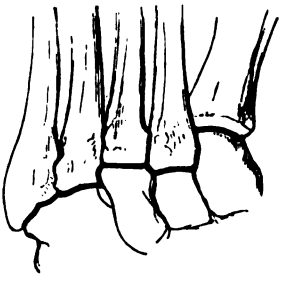
Fig. 30.

Removal of metatarsal bone of little toe; flap formed; bone being cleared.

The *metatarsal bone of the little toe* may conveniently be removed by an oval incision, so as to avoid wounding the sole of the foot. This is best done by entering the point of the knife just behind the tubercle of the bone, carrying it forwards and inwards in the line of its articulation with the cuboid, to the centre of the fourth digital interspace, and thence forwards to the web of the toe; the knife is next carried round the plantar surface of this, the incision being continued obliquely into that which has been made on the dorsum of the foot (Fig. 30). The small flap thus formed is well dissected down, the knife passed round the under surface of the bone, and the joint opened by the toe being forcibly drawn outwards, and its ligamentous connection lightly divided.

The *whole of the metatarsal bones* may be removed from the tarsal, by the operation originally planned and executed by Mr. Hey. This consists in, first of all, making a large convex flap in the sole of the foot, one horn of which commences at the tubercle of the fifth metatarsal bone, whilst the other terminates at that of the first, or rather opposite the projection of the scaphoid. A small flap is then made on the dorsum of the foot, and the articulations are exposed. These must then be opened with some care, as they are very irregular (Fig. 31); the second metatarsal bone, especially, being sunk into a kind of pit in the middle cuneiform, and the articulation of the fifth with the cuboid being very oblique. This operation is seldom practised, disease being rarely limited to the metatarsal bones, but usually implicating the joints as well. Their disarticulation also from the tarsus is very troublesome, on account of the irregularity of the line of articulation; hence it is better to saw through the metatarsus just in front of the tarsal articulations, than to attempt to disjoint the bones. A combination of these two procedures may sometimes be advantageously adopted. In one of those severe crushes of the anterior part of the foot, that are not unfrequently the result of railway injury, and in which the bones and soft parts are irregularly crushed and torn, I made a very excellent stump by disarticulating the first and the fifth metatarsal bones, and sawing across the three middle ones almost an inch anterior to their articulations with the tarsus.

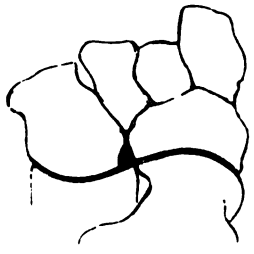
Fig. 31.



Line of Hey's operation.

Amputation through the tarsus may conveniently be performed by Chopart's operation, which consists in disarticulation in the line between the os calcis and astra-

Fig. 32.



Line of Chopart's operation.

galus behind, and the cuboid and scaphoid in front (Fig. 32). This operation may be performed either by first making the flap from the sole of the foot, and then disarticulating (Fig. 33); or, the joints having been cut through from the dorsum, the flap may afterwards be made (Fig. 34). I prefer the first plan, as it leaves a correctly fashioned flap.

In operating on the *left* foot, the knife, a stout bistoury, should be entered well behind the tubercle of the scaphoid, and carried forward for at least three inches, to about the head of the metatarsal bone of the great toe, then right across the sole, and down the outer side of the foot, as far as half an inch behind the metatarsal bone. On the *right* foot this line of incision is reversed, by the knife being entered half an inch behind the metatarsal bone of the little toe, carried forwards to the root of the toes across the sole, and down the inner side to behind the tubercle of the scaphoid (Fig. 35, 2). This flap should be made broad, especially at the inner side, but well rounded at the angles, and should consist of the whole thickness of parts in the sole of the foot, which must be well dissected out from the concavity under the metatarsal bones. A convex incision is then made along the dorsum from

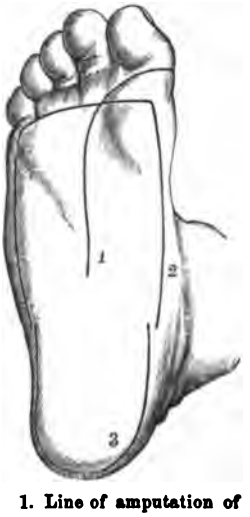
Fig. 33.

Chopart's operation: Flap formed before disarticulation.

Fig. 34.

Chopart's operation: flap formed after operation.

Fig. 35.

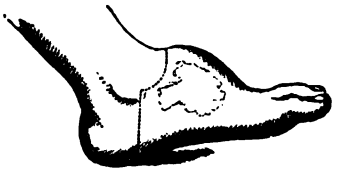


1. Line of amputation of great toe. 2. Line of Chopart's operation. 3. Line of excision of os calcis.

one horn to the other of the plantar flap; the parts are well retracted, and the articulations opened by the surgeon bearing firmly upon the anterior part of the foot, and lightly touching the ligamentous structures with the point of his bistoury. In this stage of the operation, care must be taken that the edge of the bistoury be not inclined too much backwards, lest it slip over the astragalus and open the ankle-joint; or too far forwards, lest it pass anterior to the scaphoid—between it and the cuneiform bones. After disarticulation has been produced, the projecting head of the astragalus and the articular surface of the cuboid should be sawn off. In more than one instance, I have found firm osseous anchylosis existing in the line of articulations, so as to require the use of the saw for the separation of the anterior part of the foot. The result of this operation is extremely favorable, the patient, by the aid of a properly constructed boot, being able to walk, and even dance, with very little appearance of lameness. In some cases, where the muscles of the calf are very strong, and the calcaneum projects, the heel becomes drawn up, and the centre edge of the stump made to point down in such a way that the patient is rendered lame by walking on the anterior sharp edge of the calcaneum, which irritates the flap. This condition is best removed by division of the tendo Achillis.

Disarticulation of the foot at the ankle-joint was first reduced by Mr. Syme to a regular operation. By its performance amputation of the leg may often be avoided, the patient being left with an exceedingly useful stump, which, as its covering is ingeniously taken from the heel, constitutes an excellent basis of support. The operation is performed by making an incision from the anterior part of one malleolus downwards and backwards, across the plantar surface of the heel, to a corresponding point in the opposite malleolus (Fig. 36). This flap is well dissected back, the knife being kept close against the bone, especially when it passes towards the inner side of the os calcis, in the neighborhood of the plantar arteries. An incision is next made across the dorsum of the foot, from the upper extremity of the sole-flap on one side, to that on the other, and the joint opened from the front. The lateral ligaments should now be touched with the point of the bistoury, and the tendo Achillis divided by pressing the foot forcibly downwards and cutting from before backwards (Fig. 37); by some twisting and dissection, at the same time, the os calcis is completely separated from its soft attachments, and the foot removed; the two malleoli must then be sawn off, the plantar arteries tied, and the flap brought up. A well-formed rounded stump will thus be left.

Fig. 36.



Line of incision in Syme's disarticulation at ankle-joint.

Fig. 37.

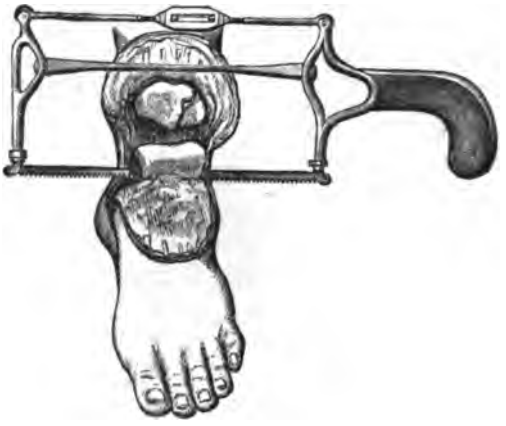
Syme's amputation.

In performing this operation, care must be taken that no button-hole apertures be made through the posterior part of the heel flap. This may commonly be avoided readily enough when the soft structures in this situation are greatly thickened and infiltrated by plastic matter, as the result of chronic disease; but, if the operation be required for injury of the foot, great care is required in digging out the heel, the integuments at the posterior part of the os calcis being very thin and adherent to the bone. It is also of importance that the incision across the heel should be carried well back over its point (Fig. 35, 3). Unless this be done, a large cup-shaped flap will be left, in which blood and pus will accumulate, and the cicatrization of the stump will be much retarded. The principal point, however, to be attended to is, that the plantar arteries are cut long; unless care be taken to do this, the flap will be insufficiently supplied with blood, and sloughing, especially of its outer angle, to which there is in all cases a tendency, will be particularly liable to occur. As union takes place by granulation, there will be a tendency to bagging in the stump; but this may be prevented by proper bandaging. The tendency to sloughing and to undue suppuration chiefly occurs in those cases in which the amputation has been performed as a primary operation for a crush of the foot. In one case in which I had occasion to perform it for an injury of this kind, a good deal of trouble resulted from this cause, though eventually the case did perfectly well, and the patient now walks with scarcely any difficulty. I look upon this operation as a most useful one in all cases requiring removal of the whole foot. The mortality attending it is, I believe, but small. I have performed it nine times without a fatal result or disagreeable consequence; and the stump that is left admits of good pressure being exercised directly upon it without tenderness or fear of ulceration.

Various modifications of Syme's amputation may at times be practised with advantage, in consequence of the soft parts covering the heel being more or less ulcerated or disorganized, so as not to admit of forming a good basis of support. In these circumstances, the flaps may be fashioned from the sides instead of from behind; and in this way I have more than once formed an excellent covering to the end of the stump. These lateral flaps should not, however, be made in any case that admits of disarticulation at the ankle in the ordinary way. They never afford so good a basis of support as the integuments of the heel, which are far more dense and elastic.

Pirogoff's amputation is characterized by the preservation of the posterior portion of the os calcis, which is left in the heel-flap. The operation is performed in the following way: An incision is carried across the sole of the foot from one malleolus to the other. This incision must not be made directly transverse to the foot, but should incline forwards obliquely, so that the centre of the incision in the sole may be at least an inch in front of a line drawn across from the tip of one malleolus to the other. The flap thus traced is dissected back for about two lines. Disarticulation of the astragalus is then effected in the usual way, by an incision across the front of the foot. A narrow amputating or a Butcher's saw is now applied to the upper and back part of the os calcis behind the astragalus (Fig. 38), and the bone

Fig. 38.



Pirogoff's amputation: Application of saw to os calcis.

Fig. 39.

Pirogoff's amputation: Appearance of parts after removal of malleolus.

cut obliquely downwards and well forwards; the malleoli are then removed, and a thin slice of the tibia with the articular cartilage taken off (Fig. 39). The opposed osseous surfaces must then be accurately adjusted, the movable flap well supported by a broad strip of plaster, and the limb laid on the outer side, with the knee placed so as to take off the tension of the tendo Achillis. The advantages of this operation over the ordinary mode of disarticulation consist in the stump being longer, to the extent of the thickness of the portion of the os calcis left in it, and being better adapted for pressure (Fig. 40); in the readiness of the union of the two applied osseous surfaces; and in the less likelihood of the supply of blood to the posterior flap being interrupted, as its vascular communications are not much disturbed, and the plantar arteries can always be cut long. These advantages are not, however, always real, and are in some degree counterbalanced by the liability to recurrence of disease in the portion of the os calcis left in those cases in which the amputation is done for disease. When it is practised for injury, however, this objection does not hold good. Another objection which has been raised against this operation, consists in the supposition that the section of two osseous surfaces exposes the patient to increased risk of osteophlebitis and pyæmia. In the first case in which I performed this amputation the patient, a healthy lad, whose foot was removed for injury, died from this cause. But subsequent and extended experience has convinced me that there is no special liability to pyæmia after Pirogoff's amputation.

Fig. 40.

Stump after Pirogoff's amputation.

[Dr. Hewson has shown that Pirogoff's amputation has the additional advantage of securing a limb upon which the patient is able to *run* as well as to *walk;* a power which is almost never retained after any other amputation of the lower extremity.—*Transact. Phila. Coll. of Phys.*, in *Amer. Journ. of Med. Sciences* for July, 1864, pp. 121–129.—A.]

The *subastragaloid amputation* is another mode of disarticulating the foot. In it the heel-flap is made as in Syme's operation, and, the articulation between the as-

tragalus and scaphoid being opened (the ankle-joint left intact), the bistoury is passed under the astragalus, between it and the calcaneum, which, together with the rest of the foot, is removed. In this amputation a good, long, useful stump results; but the cases requiring it must be few, as it does not often happen that there is disease of the calcaneum together with the anterior range of tarsal bones, without the astragalus also being involved.

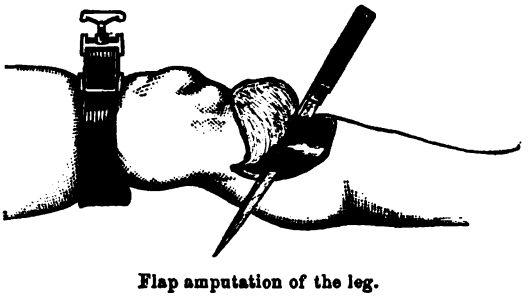
In cases of caries of the tarsus requiring amputation, it occasionally happens that the surgeon cannot determine with certainty whether the morbid action is limited to the anterior range of tarsal bones, or extends so far backwards as seriously to implicate the astragalus and calcaneum; and he is consequently unable to decide whether the foot admits of removal by Chopart's operation, or requires disarticulation at the ankle-joint. In these circumstances all doubt will be cleared, and the proper operation performed, by making an incision across the dorsum of the foot in the line of the astragalo-scaphoid and calcaneo-cuboid articulations; these are then opened, and the state of the bones is examined. If the astragalus and calcaneum be sound, or but slightly diseased on their anterior aspect, Chopart's operation may be done, and any carious bone left behind gouged away. If, on the contrary, these bones be found to be deeply implicated, the flap may be dissected back for about an inch, and disarticulation at the ankle-joint proceeded with. It may also be well to bear in mind that the tarsal articulations may have become so anchylosed, as the result of old disease, as to require the application of the saw.

Results.—The amputation of a toe, of a metatarsal bone, or even of a portion of the tarsus, is but very seldom attended by fatal consequences. Should death occur, it is usually the result of an accidental attack of erysipelas, followed by pyæmia, to which any operation is liable. Disarticulation at the ankle-joint, though necessarily somewhat more dangerous, is yet one of the most successful operations in surgery, the mortality attending it being but very small. Of nine cases in which I have done it, not one has proved fatal.

Amputation of the Leg may be performed in three situations: either just below the knee, in the middle, or in the lower third of the limb. The selection of the line of amputation must depend in a great degree upon the extent of the disease or injury, but, whenever practicable, the operation should be performed low down; the mortality diminishing in proportion as the limb is removed near to the ankle. Of 106 amputations in this situation done in Paris, there were only 13 deaths. Surgeons used formerly, even where the disease or injury was limited to the foot, to amputate immediately below the knee, in all those cases in which the patient would be obliged to wear a common wooden pin, the long leg-stump being highly inconvenient when the patient rested on his bent knee; whereas, in those individuals who could afford the expense of a well-constructed artificial limb, the amputation, when practicable, was done in the lower part of the leg. But this difficulty has of late years been removed by the introduction of a short wooden pin, in the socket of which the stump may be fixed in the extended position; and amputation in all admissible cases should consequently, even amongst the poorer classes, be done just below the calf, at the junction of the lower and middle thirds of the limb; nearer the ankle than this, it is not easy to get a good covering for the bones.

Flap amputation of the leg may be performed in the following way. The tourniquet having been applied to the artery in the popliteal space (Fig. 41), the assistant, whose duty it is to retract the flap, takes his stand in this, as in all amputations of the lower extremities, opposite to the surgeon. In the *left* limb, the point of the knife is entered at the posterior edge of the tibia, carried forwards for a distance of one inch and a half, then across the anterior part of the leg to the posterior border of the fibula, up which the incision is made to extend to a corresponding distance In the *right* leg the same incision commences on the fibular side of the limb, and terminates on the tibial. The flap thus formed,

Fig. 41.



Flap amputation of the leg.

which should be broad and well rounded, is next dissected up by a few touches of the point of the knife, and transfixion of the limb is made by passing the blade across behind the bones, from one angle of the incision to the other (Fig. 41). The posterior flap is then formed by cutting obliquely downwards and backwards, and should be about three inches long. The bones are next cleared by a double sweep of the knife, and the interosseous soft parts divided by carrying the instrument in a figure-of-8 way between the bones. In doing this, especial care must be taken not to direct the edge upwards, so as to split either of the tibial arteries, more particularly the anterior: for, as this vessel retracts above the membrane, its ligature, when divided too high, is no easy matter. If the amputation be performed just below the knee, it is possible that the popliteal trunk may be divided before its bifurcation, and thus one artery only require the ligature. In sawing the bones, the fibula should always be cut first, as otherwise it will be nearly sure to be splintered. This bone may be best divided on the left side, by sinking the hand below the level of the limb, and using the heel of the saw; and on the right, by holding the hand above the limb, and cutting with the end of the instrument (Fig. 42). After the removal of

Fig. 42.

Amputation of the leg; sawing the bone.

the limb, the sharp anterior edge of the tibia may advantageously be sliced off obliquely, so as to lessen the risk of sloughing of the corresponding flap from pressure upon a sharp ridge of bone.

If the limb be very muscular, a large pad of the muscles of the calf will be left in the posterior flap; this will usually be a good deal in the way during treatment; it may slough, and thus interfere with proper union. In some cases, I have advantageously removed at one sweep of the knife the greater part of the muscular mass thus left, thus leaving little more than a skin-flap; but, in order to avoid this, the best operation consists, in such cases as these, in forming skin-flaps on the anterior and posterior aspects of the limb, and then making a circular cut through the muscles. In this way the ends of the bones receive but a thin covering; but this matters little if the operation be performed just below the knee, for the patient, bearing upon the anterior face of the stump, exercises no pressure upon its cicatrix when an artificial limb is adapted to it.

Results.—Amputation of the leg may, upon the whole, be looked upon as a successful operation. The mortality, however, varies not only according to the situation at which the limb is removed, but also according as it is done for injury or disease and the nature of that disease. So far as situation is concerned, it may be stated, as a general rule, that the nearer the knee the greater is the danger.

In amputation of the leg for injury, the rate of mortality is, upon the whole, rather high. In the Crimea, 37 per cent. of the cases were lost. In the London and Provincial hospitals, during a period of three years, as reported in the *Medical Times*, the gross mortality amounted to 40 per cent. At University College it has

been but 24 per cent. As a general rule, primary amputation of the leg is more fatal than secondary; but at Guy's Hospital, according to Mr. Bryant, the reverse has been the case, the mortality of the secondary amputations being 66, and that of primary amputations 62 per cent. After amputation of the leg for disease of the foot or ankle, the mortality is not great: at University College it has been but 16½ per cent. In the London and Provincial hospitals generally, it has, however, amounted to 25.5 per cent. The chief causes of death are pyæmia, a recurrence of gangrene in the stump, or exhaustion.

Amputation through the Knee-joint, originally recommended by Hoin, and practised by Velpeau and other Continental surgeons, has for some years found favor in this country and America.

Amputation through the knee-joint may be performed with a long posterior and short anterior, or with a long anterior and a short posterior flap.

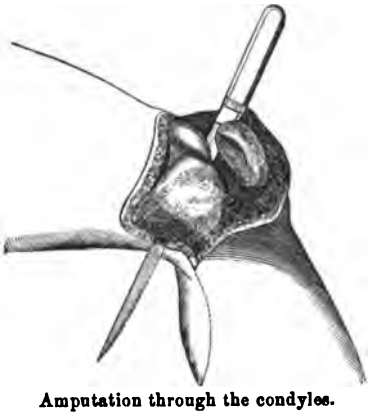
The operation with the *long posterior and short anterior flap* may be readily performed in the following way. An incision is made directly across the knee-joint, above the centre of the patella. The skin-flap thus formed is dissected back; and, the joint being opened above the patella, and the ligaments divided by a few touches of the knife, a long posterior flap is cut from the upper part of the calf of the leg, by passing the knife behind the tibia, and carrying it downwards for a suitable distance.

The operation by means of a *long anterior and a short posterior flap* is thus performed. A long square flap, rounded at the corners, is made by dissecting up the integuments and the patella from the front of the joint (Fig. 43). The articulation is thus opened; the ligaments are then divided, and a short posterior flap formed by cutting from within outwards. The popliteal artery is divided in all

Fig. 43.

Long anterior flap at knee.

Fig. 44.



Amputation through the condyles.

these cases, and with the exception of the other articular vessels, is the only one requiring ligature. The management of the patella is an important question. I think that it is decidedly better to leave than to remove this bone. If left, it forms an important addition and protection to the end of the stump. If it be removed, not only are these advantages lost, but the flap becomes so thinned and weakened as to incur danger of gangrene. I have practised the operation both ways, and have found it most advantageous to leave the patella. There is only one objection to this; and that is the chance of the patella being drawn up, as occasionally happens, upon the anterior part of the thigh. This is best prevented by turning up the flap, and cutting across the tendinous insertion of the quadriceps extensor.

About the management of the cartilaginous surface of the femur in these amputations, there is a difference of practice. Some surgeons prefer leaving it; others, again, saw it off. I prefer the latter method. The plan that I have usually adopted in these cases has been, after the disarticulation has been completed, to remove the incrusting cartilages by means of a fine-bladed Butcher's saw, cutting round and not across the end of the bone; and thus not shortening the stump, but simply

removing the incrusting cartilage, which would otherwise necrose or disintegrate, and thus interfere with ready union. The inner surface of the patella should be removed in a similar manner, and the flap then laid down. This will be found to furnish an excellent covering to the bone; the patella, and the thick, tough, and extensile integuments of the knee, forming a good basis of support for the limb to bear upon, and one well adapted for pressure.

This amputation may sometimes conveniently be varied by being done *through the condyles* without previously opening the knee-joint (Fig. 44). This operation, like that of amputation through the knee-joint, may be done either with a long posterior flap or a long anterior one containing the patella. Of the two methods, I prefer the last, as giving the best subsequent result with least cicatrix. The advantages of this operation over amputation of the thigh higher up are undoubtedly great. The limb being removed at a greater distance from the trunk, the shock to the system will be less, and the rate of mortality diminished; the medullary canal of the femur not being opened, there will be less likelihood of osteomyelitis; fewer ligatures will be required, and, if a long posterior flap have been made, these may be brought out through an opening made in the centre of it, as Blandin recommends; and lastly, a longer stump will be left, the movements of which will be more under the control of the patient than those of a shorter one, owing to the proper muscles of the femur not being divided, and all the movements of that bone being thus preserved in their integrity. There is a little point of practice that I have found useful in this amputation, viz., to round off with the saw the sharp edge left on the condyle after the removal of its cartilaginous surface, as this otherwise may press injuriously upon the flap.

Results of Amputation through the Knee-joint or Condyles of the Femur.—So far as life is concerned, these operations have been successful. Dr. Markoe finds that, of 49 cases in which amputation through the knee has been practised, there have been 17 deaths—a rate of mortality equal to only 37 per cent. The statistics through the condyles of the femur immediately above the joint have not been made out.

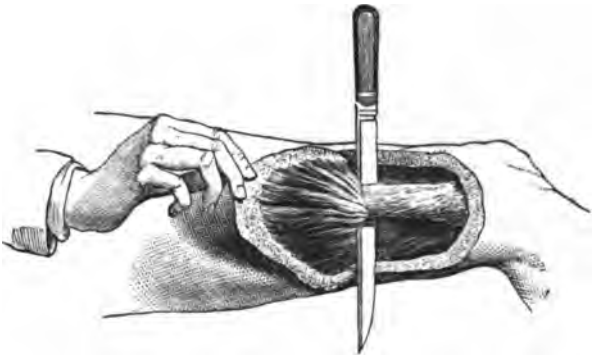
[Dr. John H. Brinton, of this city, under whose able supervision the earlier American editions of this work were published, has collected histories of 164 cases of amputation through the knee-joint, recovery following in 111 of the cases, and death in 53, a mortality of 32⅓ *per cent.* Of 211 cases recorded in the office of the Surgeon General U. S. A., 106, or just one half, died. The difference in mortality depending upon the retention or removal of the condyles of the femur is about ¼ *per cent.* in favor of the former. Amputation immediately above the condyles, with a long skin flap from the front of the joint, gave in Mr. Carden's hands but 5 deaths in 30 cases.—*Am. Journ. of Med. Sciences* for April, 1868, pp. 305–338, and 555.—A.]

These amputations present three great advantages over those higher up. 1. As the medullary canal of the femur is not opened, the patient is saved all that risk which results from suppuration within that canal, the infiltration of pus into it, and the consequent liability to suppurative phlebitis of the veins of the bone, and consecutive pyæmia. 2. He is provided with a long thigh-stump, which gives increased leverage in using an artificial limb. 3. When the amputation is practised with the long anterior flap containing the patella, the end of the stump will be protected by the dense and tough integumental and aponeurotic structures naturally situated in front of the knee-joint, which admit of pressure being made upon them without fear of excoriation; the cicatrix being drawn up behind the end of the stump, and altogether away from its surface.

Amputations of the Thigh are commonly required both for accident and for disease. They may be performed in three situations: immediately above the knee, in the middle of the limb, or in its upper third. Amputation just above the knee is best done by lateral flaps; for this reason, that the mass of muscle in this part of the thigh lies on each side of the limb, the central portion being occupied in front by the tendinous and aponeurotic structures connected with the patella, and behind by the upper triangle of the popliteal space; hence, if antero-posterior flaps be made here, they will be thin and tendinous in the middle; whereas the lateral flaps are uniformly thick and fleshy. In the middle and upper thirds of the thigh, the antero-posterior flaps leave the best result, and give the best covering to the bone. If lateral flaps be made in these situations, the end of the bone is apt to be drawn up into the angle of the wound between the flaps, which fall away behind it. In amputation in the

lower or middle third, a tourniquet may be applied high on the limb; but when the operation is done in the upper third, there is no space for the application of this instrument, and the surgeon must then trust to an assistant compressing the artery as it passes over the brim of the pelvis. Compression is best made by grasping the great trochanter with the fingers of the right hand, and then applying the thumb firmly over the artery; upon this the other thumb is then pressed as firmly as possible, and thus all chance of letting the vessel slip is prevented.

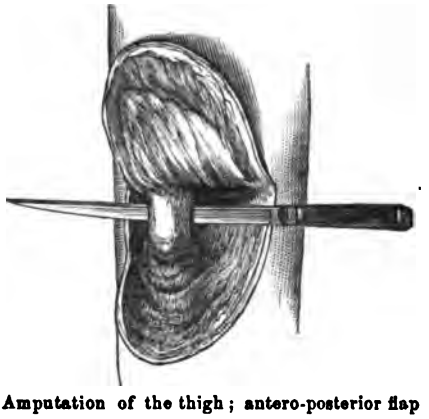
Fig. 45.



Amputation of the thigh by lateral flaps.

Amputation above the knee, or *Vermale's operation*, is best done by lateral flaps. In performing this operation, the outer flap should always be made first. The point of the knife, being entered in the middle of the thigh, about three inches above the upper border of the patella, is carried close round the bone and brought out through the centre of the ham; the flap is then cut downwards and outwards; the knife, being entered again in the upper angle of the incision, is carried close round the bone to its inner side, and the inner flap made by a sweeping cut (Fig. 45). Unless the blade be kept in contact with the bone in this situation, the femoral artery is very apt to be split. The flaps being then retracted, the bone is cleared by two sweeps of the knife, and sawn about four inches above its articular surface.

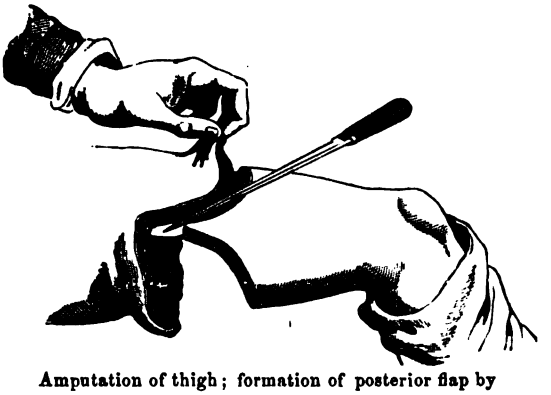
Fig 46.



Amputation of the thigh; antero-posterior flap operation.

In the *middle or upper third of the thigh*, the *antero-posterior flap operation* is to be preferred. In ordinary cases, the anterior flap may first be made, and the posterior one subsequently fashioned by transfixion (Fig. 46). If, however, the patient be very much emaciated, it is difficult to get a good cushion from the anterior part of the thigh in this way; and it is consequently preferable to follow the plan recommended by Mr. Luke, of making the posterior flap first by transfixion, and the anterior one afterwards by cutting from without inwards (Fig. 47). In some instances in which the tissues at the posterior part of the thigh are much diseased or injured, whilst those on the anterior aspect of the limb are sound, a very good stump may be fashioned by making a long square anterior flap by transfixion, and then cutting at one stroke of the knife through the soft parts at the posterior aspect of the limb, in a somewhat oblique direction from below upwards. The anterior flap, when laid down, will form the

Fig. 47.



Amputation of thigh; formation of posterior flap by transfixion; of anterior, by cutting from without inwards.

cushion at the end of the stump. If the patient be excessively muscular, and the amputation be a primary one, I think it is better to make skin-flaps with a circular incision through the subjacent soft parts. In this way the large gaping fleshy stumps are avoided, which commonly run into unhealthy suppuration and sloughing, leading to the death of the patient.

Amputation through the trochanters may sometimes be advantageously practised, either in severe compound fractures of the lower part of the thigh, or in cases of malignant cartilaginous or osseous tumors of the lower and middle third of the femur; and thus the more severe and dangerous operation of disarticulation at the hip may be avoided. Indeed, should it be found, after section of the bone, that it is so much injured or diseased as to require removal at the joint, this may readily enough be done by dissecting the head out of the acetabulum with a strong scalpel or bistoury.

Results.—The mortality after amputation of the thigh is very considerable when the operation is done for injury, more particularly for compound fracture of the femur itself. The statistics of the operation have already been given at pp. 60, 61, and 62; I need not therefore repeat them here. It is a remarkable circumstance, that in some hospitals primary amputation of the thigh seems almost invariably to have been a fatal procedure; whilst in other institutions the mortality has not exceeded 50 or 60 per cent. At Guy's and at University College, secondary amputation of the thigh has been more fatal than the primary.

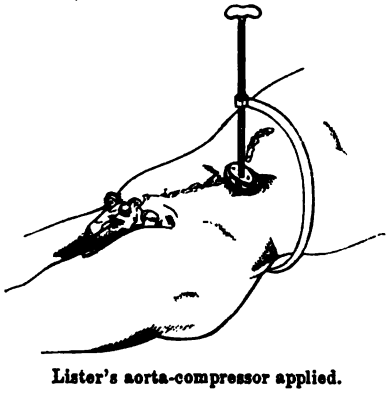
The result of amputation of the thigh for disease of the knee-joint depends entirely upon whether the affection is acute or chronic. In acute suppurative disorganization of the knee, amputation of the thigh is most fatal; indeed, so high is the rate of mortality, that it is doubtful whether it is proper to perform the operation in that stage of the affection. In chronic knee-joint disease, on the other hand, the operation is most satisfactory and successful; death seldom resulting unless it have been deferred to the last stage of exhaustion.

The causes of death vary according to the condition for which the operation is performed. In primary traumatic amputation, the fatal event is chiefly brought about by exhaustion, traumatic gangrene of the stump, or secondary hemorrhage. In secondary amputations, and in those for disease, pyæmia, erysipelas, and exhaustion are the usual causes of death.

Amputation at the Hip-Joint.—This formidable operation is of comparatively recent introduction into surgery. During the early part and middle of the past century, its practicability was warmly canvassed. It was performed on animals experimentally. It was found that patients affected with ergotism, whose lower extremities had become gangrenous, and had separated at the hip-joint, survived; and, at last, in the year 1774, the first amputation of the kind was done by Kerr of Northampton, on a girl aged 12, affected with coxalgia and lumbar abscess. The operation was unjustifiable in such a case, but the patient lived 17 days, and thus its practicability was demonstrated. Larrey performed it in 1793 for the first time for gunshot injury; and since that time the operation has become an established one in surgical practice, civil as well as military.

Amputation at the hip-joint may be and has been performed in a variety of ways, which it is not necessary to detail. The most convenient methods are those by *antero-posterior* and by *lateral flaps*. Of these, that by *antero-posterior flap* is the simplest and speediest, and leaves the best stump. It consists in making a large and thick anterior flap by transfixion, and a short posterior one from the gluteal region and back part of the thigh. In order to perform this operation properly, the patient's body must be brought well forward upon the edge of the table, so that the nates project beyond it, and be steadied by strong bandages. One of these must be passed between the sound thigh and the perinæum, and attached to the upper end of the table; another should be carried across the pelvis to the lower end; and the sound limb must be tied to the

Fig. 48.

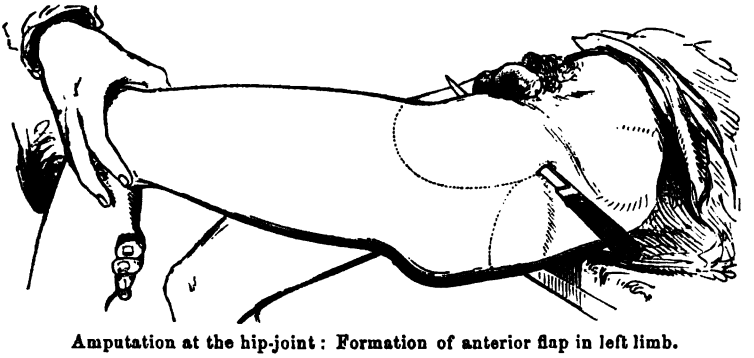


Lister's aorta-compressor applied.

leg of the table. The circulation through the limb should then be arrested by the application of Lister's compressor to the abdominal aorta (Fig. 48). This is a most invaluable instrument, completely restraining the circulation through the lower extremities, depriving this operation of its great danger—undue loss of blood, and enabling the surgeon to complete it without hurry or anxiety on this account. The surgeon must have three assistants on whom he can fully rely. Assistant No. 1 takes charge of the flap, compressing the femoral vessels; and, in the absence of the abdominal compressor, on his trustworthiness the patient's life is mainly dependent. Assistant No. 2 takes charge of the limb; flexing it slightly on the abdomen in the first stage of the operation, whilst the anterior flap is being made; forcibly abducting and bending it backwards during the second stage, when the surgeon is opening the capsule of the joint and making the posterior flap. On the way in which he performs these duties, the facility with which the surgeon performs the operation is mainly dependent. To assistant No. 3 is consigned the care of the compressor of the abdominal aorta. After the removal of the limb, assistant No. 2 aids the surgeon in ligaturing the arteries. These preliminaries having been arranged, and the duty of each assistant assigned to, and distinctly understood by him, the operation is to be performed in the following way.

The surgeon, standing on the left side of the limb to be removed, feels for the bony points which guide his knife, viz., the tuber ischii and the anterior superior spine of the ilium. The knife, which must have a blade twelve inches long, requires to be entered, and the flap to be made, in different ways, according to the side of the body on which the operation is performed. If it be on the *left* side, the knife should be entered about two fingers' breadth below the anterior superior spine of the ilium, and carried deeply in the limb behind the vessels, directly across the joint; its point being made to issue just above the tuberosity of the ischium (Fig. 49). In transfixing on this side, care must be taken not to wound the scrotum or

Fig. 49.



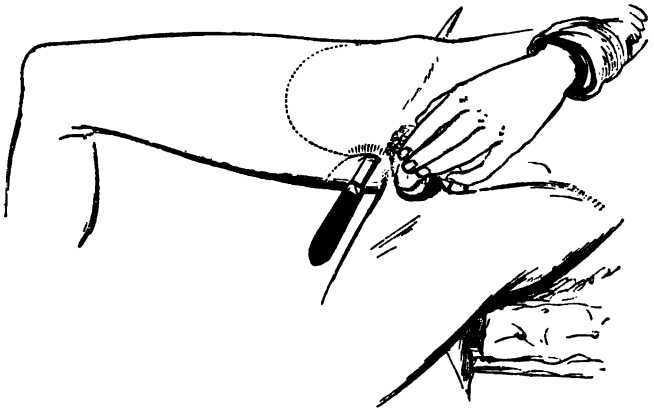
Amputation at the hip-joint: Formation of anterior flap in left limb.

the opposite thigh; the back of the knife must run parallel to, but not against the pelvis, and the point must not be held too high, lest it enter the obturator foramen. The anterior flap must then be rapidly cut downwards and forwards, about five inches in length. The limb, which has, during this stage of the operation, been raised and slightly flexed upon the abdomen, must now be forcibly abducted and everted; the capsule of the joint is then to be opened by a firm cut with the point of the knife. So soon as this is done, the head of the femur must be pushed up by forcibly depressing and abducting the limb, so that it may start out of the acetabulum; the heel of the knife is then passed behind it, the remainder of the capsule cut across, and the posterior flap rapidly fashioned by carrying the knife downwards and backwards through the thick muscles in this situation. The posterior flap may be about four inches in length; but this must of course vary according to the length of the anterior flap. When the amputation is performed on the *right* side, the anterior flap is made by entering the knife just above the tuberosity of the ischium, and bringing it out two fingers' breadth below the anterior superior spine of the ilium (Fig. 50); the remaining steps of the operation being performed as in the last case.

In consequence of the extent to which the limb that is about to be removed may

have been injured, or to which it is encroached upon by disease, it is not always easy to make the anterior flap of the size or shape that I have described. A little

Fig. 50.



Amputation at the hip-joint: Formation of anterior flap in right limb.

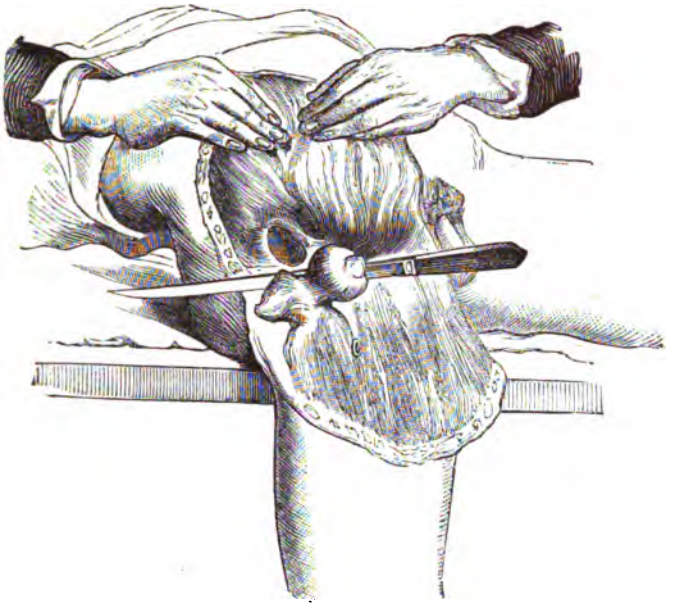
management on the part of the surgeon will enable him to take the requisite amount of covering from the outer or inner parts, by inclining the point or the heel of the knife downwards, as the case may require; or he may even make the anterior flap by incision from without inwards, instead of by transfixion.

When the femur is entire and unbroken, assistant No. 2 uses it as a lever, bringing the lower end of it in the second stage of the operation downwards and outwards, thus causing the head of the bone to press against the anterior part of the capsule, and to start out with a peculiar sucking noise as soon as that is opened. Should, however, the bone have been fractured high up, this movement cannot be given to it; and then the surgeon must grasp the upper end of the femur below the trochanters, so as to steady and push it back as he is disarticulating its head. In two of the cases in which I have amputated at the hip-joint, it has been necessary to do this —in one, in consequence of the crush of the bone, two inches below the trochanters, by a railway accident; in the other, in consequence of its spontaneous fracture at the junction of its upper and middle thirds, in a case of rapidly growing malignant disease of the bone. This fractured condition of the femur necessarily makes the operation somewhat more difficult, as the surgeon is deprived of the long lever afforded by the limb in its sound state, by which the head is tilted upwards and forwards, and the capsule put on the stretch so as to be brought directly against the point of the knife as it is drawn across it.

In amputation at the hip-joint, the great immediate danger to be apprehended is excessive hemorrhage, the incisions being made so high up that no ordinary tourniquet can be applied. By means of Lister's compressor, the circulation through the abdominal aorta may be arrested, and thus the danger obviated. It is of great importance to perform the operation with as much rapidity as possible, and the disarticulation ought to be effected in at most thirty or forty seconds; and it may be done in much less time than this. The arrest of the hemorrhage during the operation must be intrusted to an assistant who can be fully relied on. After the abdominal compressor has been applied, and the flow of blood through the aorta arrested, his business should be to compress the artery above the brim of the pelvis, and then to follow the knife in the first incision, and, as the anterior flap is being made, slip his fingers under it and grasp it firmly above and below, so as to compress the femoral artery in it, which is divided as the knife cuts its way out (Fig. 51). By grasping the flap tightly, there will be but little risk of hemorrhage from the femoral artery, even when the abdominal aorta has not been compressed by the application of the tourniquet; but lest this should slip, or the assistant whose duty it is to grasp the flap by any chance should fail in holding it properly, it may be well to direct one of the assistants, whose business it is to steady the trunk, to have his thumb well pressed down into the iliac fossa, so as to compress the artery against the brim of the pelvis. As the posterior flap is being made, the bleeding from the gluteal and

sciatic vessels, which is often very free, may be arrested by two assistants who should be ready to cover and compress them with the fingers or dry sponges. The arteries may then be ligatured one by one, as the assistant raises his fingers from them. If we have good hold of the femoral, the vessels in the posterior flap may be

Fig. 51.



Amputation at hip-joint; Compression of femoral artery in anterior flap.

tied first; but if the femoral be insecurely held, it must be first tied. The femoral arteries, both superficial and deep, will be found to be cut long, and to project from the muscles by which they are surrounded, so as very readily to be seized by the fingers or forceps, pulled out, and ligatured. The arteries in the posterior flap and on the inner side of the joint will be found in the inter-muscular septa. The flaps are to be brought together by six or eight pieces of suture, and a few long strips of plaster. The turn of a broad bandage may then be passed round the abdomen, and the end brought up from behind under the stump so as to support the flaps.

Results.—The mortality after amputation at the hip-joint is necessarily very high. This we should naturally expect from the size of the part removed and the consequent shock to the system. The rate of recovery varies greatly according to the condition of the limb that necessitates the operation. Thus, amputation at the hip-joint had been performed, so far as I can ascertain from published cases, 126 times up to the year 1864; of these 76 died. But in 47 instances it was for injury: of these 35 proved fatal; whilst in 42 cases in which it was done for chronic diseases, 24 recovered and only 18 died.

Primary amputation at the hip-joint in cases of severe injury of the thigh, gunshot or otherwise, with comminution of the femur, is one of the most fatal operations in surgery. In all the 12 cases in which it was done in the Crimea it proved fatal; and M. Legouest has collected 30 cases of this amputation for gunshot injury, in all of which the operation terminated in death. Indeed, up to the time of the war of the rebellion in America, there was no authentic instance of recovery under these circumstances. But in an elaborate and most able surgical history of that great war, published by the Surgeon-General, 19 cases of primary amputation at the hip-joint for gunshot injury of the femur are related. Of these 11 died from the immediate shock of the operation; 5 died between the 2d and the 10th day; one, a man 28 years of age, who had amputation at the hip performed by Surgeon Shippen seven hours after the receipt of his wound, was in perfect health four years after the operation; and the remaining two cases had been cured, so that one was alive and well two, and the other six months, after the amputation.

Intermediate operations, or those done during the inflammatory period, have been very unsuccessful: 18 cases that occurred in the American war were all fatal.

Secondary amputation, in cases of attempted preservation of the limb after severe injuries and gunshot wounds, has been far more successful. Four cases in which J. Roux practised it in the French campaign of 1859 in Italy all recovered, as did two out of nine in which it was practised in America.

Re-amputation at the hip-joint for diseased thigh-stumps has also been a successful operation: 4 out of 7 American cases recovered.

Amputation at the hip-joint for disease of the femur has undoubtedly become less fatal of late years than was formerly the case. This is doubtless owing partly to the operation being submitted to at an earlier stage of the disease; to a better selection of cases; possibly to improved methods of after-treatment; but mainly, I believe, to the influence of anæsthetics, by which the shock to the system necessarily resulting from so very severe a mutilation is materially lessened. The employment of Lister's aorta compressor will probably still further reduce the mortality by lessening the loss of blood, and thus proportionately diminishing those risks of low secondary disease that are induced by serious hemorrhage.

[To understand fully the descriptions given of the various amputations described in this chapter, it must be borne in mind that the author supposes the surgeon to stand with his right hand towards the patient's head, and his left hand resting on the part to be removed—exactly the opposite of the position usually recommended and adopted in this country.—A.]

CHAPTER IV.

LOCAL HYPERÆMIA.

THE forms in which Local Hyperæmia, or the undue supply of blood to a part, is met with, are threefold; viz: 1. *Congestion;* 2. *Determination;* 3. *Inflammation.* Of the nature, results, varieties, and treatment of these, we will speak in order.

CONGESTION.

Congestion plays an important part in surgery: it occasions serious structural changes, and runs into inflammation. Congestion is always a passive and mechanical condition, hence the term *active* congestion should not be employed. Indeed, what has been described as "active congestion" is in reality a variety of the inflammatory process.

Congestion is a true hyperæmia; in it we find not only that the blood is greatly increased in quantity, but that it circulates languidly through the part and is of a darker color than natural. The arteries are at most of their normal size, perhaps even contracted; the veins and capillaries are greatly distended by the slowly moving fluid. When the circulation in the congested part becomes completely arrested, *stagnation* is said to have occurred.

Symptoms.—These are well marked when the part affected can be seen or felt; when congestion occurs in an internal organ, they are often very obscure. Congestion of an external part may be recognized by the changes it induces in the color, the feel, the size, the sensibility, the temperature, and the functions of the part. The color of a congested part ranges from purplish red to a dusky brown; its size is increased; it feels soft, and pits under the pressure of the finger. The patient is often conscious of a heavy, dull, aching sensation in it, scarcely amounting to pain, but yet attended with uneasiness. The temperature is never above, but often below, the natural standard, and the functions are lessened in activity.

The existence of congestion in an internal organ may be ascertained by finding its size increased, and its functions modified, with a sensation of weight in it.

Effects.—These are of much surgical importance. The first change that usually takes place is an effort in the vessels of the part to relieve themselves, by a transu-

dation of the more watery constituents of the blood into the surrounding areolar tissue. Hence the interspaces of this tissue are distended by the effused fluid, giving rise to *œdema*.

If the turgidity of the vessels be great, and their walls at the same time weakened, rupture will occur, and hemorrhage to the surface, or into the substance of the part, will ensue.

In consequence of the infiltration of the areolar tissue, softening takes place, nutrition becomes less and less perfectly performed, and ulceration at last occurs. These changes we not unfrequently see in the integuments of the legs of old people. In other cases, the vessels becoming permanently dilated, the part assumes habitually a redder or darker tint, becomes swollen, and, if it be a mucous surface, it may be roughened and papillated, as is often observed in a congested conjunctiva.

Causes.—The causes of congestion, always mechanical, may be divided into two great classes, which we often find conjoined: 1. Those causes that act by obstructing the return of the venous blood; 2. Those that act by enfeebling the walls of the capillaries and veins, so that they are no longer able to withstand the outward pressure of the contained blood.

1. Amongst the first set of causes, may be specified any condition that directly and immediately interferes with the proper return of blood through a vein; in this way the pressure of a tumor upon such a vessel produces congestion of the part from which it carries off the blood.

Venous obstruction does not always act in so direct a manner as this; for it not unfrequently happens, that obstruction to the return of blood from one organ will occasion a congestive condition of the vessels in a distant one. Thus we find that some forms of congestion of the eyeball are due to obstruction in the branches of the portal veins.

The long-continued dependent position of a part may occasion its congestion by the blood mechanically gravitating into it, and overcoming, by the pressure thus brought to bear upon the vessels, the onward movement of the fluid within them. Thus we see congestion of the legs from long-continued standing; of the hemorrhoidal veins from an habitually sedentary life; and of the posterior part of the lungs of those who have been long confined to the recumbent position.

Among the most common causes of congestion that act by enfeebling the vessels, we find the debility of old age, acting partly by lessening the tone of the vascular system generally, and partly by inducing a diminution of the propulsive power of the heart. So also cold, by lessening the vitality and retarding the circulation of a part, produces congestion in it. Certain typhoid or adynamic states of the system favor the occurrence of congestion in the more dependent parts. And, lastly, inflammation may terminate in this condition.

The obstructive causes are especially apt to induce congestion when they occur in connection with a feeble condition of the vascular system.

Treatment.—The treatment of congestion has strict reference to its cause.

The first indication consists in the removal of any source of obstruction to the return of blood from the part, as by unloosening a ligature, or elevating a part that has been too long dependent; or, less directly, as in the case of many internal congestions, by restoring the freedom of the circulation through the larger viscera. Thus a congested eye or pile may be relieved by the removal of hepatic or portal obstructions.

The next indication consists in lessening the quantity of blood in the congested part. The mere removal of the obstructing cause may effect this. In other cases, the direct removal of the blood by scarification, as in a congested conjunctiva, or by leeches, as around a turgid pile, affords immediate relief. In some parts, again, the judicious application of a bandage will prevent or remove congestion. With this view, the hand and arm are bandaged before the apparatus for a fractured clavicle is applied: and in varix the leg is supported by an elastic stocking, to lessen the pressure of blood in the dilated veins.

The third indication in the treatment of congestion consists in constringing the dilated vessels by the direct application of an astringent to them; thus we habitually apply nitrate of silver to a congested mucous membrane, and cold douches to many external forms of the disease.

DETERMINATION.

Increased vascular action lies at the bottom of most surgical processes; few important surgical actions taking place without it. No process by which the separation of dead parts is effected, or by which the repair of wounds or ulcers is carried out can occur without an increased activity of the vessels of the parts concerned. Every tissue is susceptible of it; and the surgeon often excites it intentionally as one of the most efficient of his therapeutic means; hence an acquaintance with the elements and the details of the process, with its nature, symptoms, causes, results, and terminations, is of the first moment.

Increased vascular action is of two distinct kinds: 1. *Determination;* 2. *Inflammation.* These two conditions, though in practice most commonly found more or less conjoined, require to be studied separately.

In *determination*, the blood is increased in quantity, has a bright arterial color, and circulates through the parts with great rapidity. This condition, which is often called "increased action," consequently resembles congestion in the blood being in excess, but differs from it in every other respect.

Determination of blood is a vital process, often of a very transitory character, and frequently occurs as a normal action in those conditions of the system in which, for temporary purposes, an increased afflux of blood is called for by particular organs. The enlargement of the mamma before lactation, and the turgor of the erectile tissues, afford familiar illustrations of this act. The surgeon often employs determination of blood for therapeutic purposes. In these circumstances, therefore, it cannot be considered a disease.

When determination of blood is of a chronic or continued character, it may lead to such changes in the appearance, structure, and functions of a part as materially modify its nutritive and secretory activity, and then it becomes truly a disease. In these circumstances, the part is often said to be in a state of "chronic irritation."

Symptoms.—The symptoms of determination of blood are those that we should expect to result from an increased quantity of blood rushing with increased velocity through the affected textures. There are redness of a bright scarlet hue, swelling from turgescence of the vessels, heat cognizable to the surgeon as well as to the patient, a feeling of fulness and of throbbing, with an increase, in the quantity of the secretions of the part; in fact, all those symptoms that characterize inflammation in the milder forms, but in a minor degree and of a less persistent character.

Effects.—The effects of determination, when acute, consist either in rupture of the affected vessels, and a natural relief by the hemorrhage which ensues, as may happen in piles after a dose of aloes has been given; or, if a free surface or a gland be affected, in the pouring forth of the secretions of the part, considerably augmented in quantity and perhaps deviating somewhat from their normal character, as in lachrymation after the introduction of a grain of snuff into the eye. When this effusion occurs within shut serous sacs, dropsical accumulations may ensue.

The more remote effects of chronic determination of blood to a part consist in permanently increasing the nutritive activity, and thus leading to induration and hypertrophy. Or, determination of blood may result in true inflammation.

Causes.—The causes of determination of blood are threefold.

First, an external irritant directly applied to a part will induce it, as when a grain of dust is blown upon the conjunctiva. Secondly, internal irritation, as increased use of a part, will determine an increased flow of blood to it. Thus, using the eyes much in microscopical investigations may produce redness, watering, and irritation of those organs. To this class of causes may be referred the various forms of normal determination. The last class of causes consists in the repercussion of blood from one part to another.

Treatment of determination of blood is nearly identical with that of the milder forms of inflammation; hence we shall reserve the consideration of it until we come to treat of that disease.

INFLAMMATION.

The study of the inflammatory process is one of the most complex and difficult on which the surgeon can enter; but the labor required to master its details is well bestowed, inasmuch as an acquaintance with its nature, symptoms, and progress,

gives an insight into a greater part of the science of surgery. The management of inflammation as it affects different tissues and organs, and thus constitutes distinct diseases, comprises a great part of the duties of a surgeon. The Theory of Inflammation is a purely physiological and pathological study; and, however interesting its investigation may be, yet, as the discussion of this subject belongs rather to the domain of General Pathology than to that of Practical Surgery, it cannot consistently be entered upon here; but, regarding the subject from a surgical rather than from a physiological or pathological point of view, we must discard all hypothesis and confine ourselves to the results of trustworthy observation.

Phenomena.—In congestion the quantity of blood is increased, but the rate of its motion is lessened; in determination we have everything augmented: there is an increased size of the vessels, and an increased quantity of blood within them, circulating through them with increased velocity. In inflammation we have a combination of these conditions: the vessels are increased in size, the quantity of blood is augmented, and its motion becomes more rapid: but at the same time there is a tendency to the arrest of the flow of blood. In studying the phenomena of inflammation in the web of the frog's foot under the microscope, we observe that the first change on the application of a stimulus is the momentary contraction followed by dilatation of the artery; the flow of blood through it and the capillaries is at first accelerated; retardation from congestion then ensues; and lastly, stagnation at points.

At these centres of commencing stagnation, it will be seen that the blood appears to ebb and flow, oscillating to and fro, and then stopping at last: the immediate stagnation taking place in those capillaries which are not in the direct line of passage from an artery into a vein, and the arrest taking place by the red corpuscles coalescing by mutual adhesion into masses, which, after being carried bodily up and down more and more slowly, at last appear to block up the vessel, partly by overcrowding and distending it, and partly by becoming adherent to its walls: this adhesion usually commencing at the angle of union between two capillaries. Around the stagnant part the vessels are crowded by an aggregation of the red corpuscles, which appear to be more closely packed in consequence of the draining away of the liquor sanguinis. The blood does not enter the part of the vessel in which stagnation has taken place, but passes off by a collateral branch (Wharton Jones).

At this part, also, where the circulation is retarded, the white corpuscles may be seen to be increased in quantity, and appear to be adherent to the wall of the vessel, along which they are either stationary, or at most roll but languidly. Around the whole of this area, in the centre of which there is stagnation with retardation of the blood, there is that increased rush of an increased quantity of blood characteristic of determination.

These are the general phenomena presented by an inflamed part when studied under the microscope. In order to become acquainted with the elements of this process, we must analyze the condition of (1) the *Vessels*, and (2) the *Blood*.

1. *Vessels.*—The arteries, capillaries, and veins are all enlarged; not only those in the part inflamed, but those around and leading to it, so that more blood is conveyed with greater rapidity to the seat of disease. Is this enlargement of the inflamed vessels primary or not? This would appear to depend greatly upon the stimulant that excites the inflammation, and perhaps on other circumstances that we cannot readily appreciate; thus, if a weak solution of salt, or ice-cold water or spirit of wine, be applied to the web of a frog's foot, there is a momentary constriction of the arteries and retardation of the flow of blood, followed by rapid dilatation and accelerated flow. In other cases again, as Wharton Jones has observed, the dilatation may be primary, no contraction preceding it, as happens when vinum opii or a strong solution of salt or of sulphate of copper is applied to the part. The solid sulphate of copper produces speedy, complete, and permanent contraction.

Though the vessels generally are enlarged, the arteries especially become dilated; and this dilatation implicates to a considerable distance the afferent vessels, which can be felt, by the volume of their pulsations, to be increased in bulk. That the coats of these vessels leading to the inflamed parts are dilated in consequence of being relaxed, is evident from the fact that the pulsation in them is stronger and more forcible than in other parts of the arterial system, though equally dependent upon the heart's action, to which their diminished tonicity offers less resistance. This may be readily observed in the pulsation of the digital arteries in a case of

whitlow. That the vessels convey more blood *through* as well as *to* the inflamed part, is proved by the observation of Lawrence, who found that in bleeding a patient, with whitlow of one hand, in both arms, more blood flowed from the inflamed than from the sound limb, in the same space of time.

In consequence of the dilatation of the smaller arteries and capillaries of the part, red corpuscles are admitted in crowds where single files could only penetrate before; hence an appearance of new vessels is presented, though none are in reality formed. It is in this way that the surface of the conjunctiva may in a few hours be brightly reddened, not by the formation of new vessels, but by dilatation and accumulation of blood in previously existing ones.

Besides this dilatation of the smaller vessels of the part, the arteries become elongated, tortuous, and waved, increasing in length as well as in diameter. The German pathologists—Kölliker, Hasse, and Bruch, whose views are confirmed by Paget and Wharton Jones—have observed that the arteries of the inflamed part have a tendency to become dilated at points, so as to present small varicose or aneurismal pouches projecting from their walls, or fusiform dilatations of their whole diameter. These changes would appear to arise from one of two causes: either that the vessel is constricted at points between which it maintains its normal width, and thus that the dilatation is apparent and not real; or that it is actually dilated where it appears to be so.

I shall not enter upon the question as to the causes of these changes in the vessels; how a stimulant acts in giving rise to them, and what share the nerves of the part may have in their production; as these are points out of the scope of this work, and, indeed, appear as yet to be undecided.

2. *Blood.*—The changes that the blood undergoes in inflammation are fully of as great importance as those presented by the vessels.

The most apparent physical change met with in this fluid is, that it appears to have become thinner, as was long ago pointed out by Hewson. But there are other changes that can only be appreciated by chemical and microscopical research, which Mr. Lister has shown to be similar to those changes that take place in the blood when separated from the living body. These we must study, as they affect the different constituents of the blood.

The *red particles* have been shown by Andral and Gavarret to be increased in quantity in the early stages of inflammation; but, as the disease continues, they speedily diminish in number, falling below the natural standard, as Wharton Jones and Simon have pointed out. No other apparent change takes place in these particles, except their increased adhesiveness and their tendency to aggregation into clusters by the cohesion of their flat surfaces. This clustering of the red particles, first pointed out by Wharton Jones, takes place in the vessels as well as out of them, and is considered by its discoverer, and by Henle, to be owing to inspissation of the plasma.

The *white corpuscles* have excited much attention of late years in connection with the arrest of circulation in inflammation. Dr. C. J. B. Williams has shown that they appear in increased numbers in the inflamed part, and by their adhesion to the walls of the vessels become one principal source of the arrest of the circulation. There are several questions, however, with reference to the white corpuscles: 1. As to their actual increase; 2. As to the cause of this increase in their numbers; and 3. As to their greater disposition to adhere to the vessels. Their increase in inflammation is stated by Wharton Jones to be partly relative, owing to the diminution in the red particles; and Paget, as well as other observers, is of opinion that it is only in sickly and young animals kept for the purpose of experiment that this increase has been observed, never being met with in healthy animals, or in the human blood taken from inflamed parts. Hence he infers that they are only met with in large numbers in inflammation, when existing numerously elsewhere. Their appearance in large numbers in the vessels of the inflamed part, and their accumulation here, is ascribed by Wharton Jones simply to retardation of the circulation; this condition being consequently the effect and not the cause of the obstruction, which, however, they may mechanically increase when it has been once induced.

The natural adhesiveness of the white corpuscles to the sides of the vessel is such as to require a brisk current to sweep them along; hence, when the force of this is lessened, as is the case in an inflamed part, they are not readily detached; but, as it has been shown that the tendency to cohesion is increased in the red cor-

puscles, it is but reasonable to believe, with Dr. Williams, that the adhesiveness of the white ones may also be augmented. This increased adhesiveness is due, according to Mr. Lister, not to changes primarily induced in the blood itself by the irritant application, but secondarily to changes taking place in the tissues of the irritated area. Mr. Lister has found, as the result of numerous experiments on the frog's web, that the application of irritants of various kinds produces an obstruction to the passage of the corpuscles, both red and white, in their progress through the dilated arteries of the irritated part, in consequence of their disposition to adhere in an abnormal degree to one another and to the walls of the vessels. This adhesiveness does not occur unless the tissues of the part are irritated, and never exceeds, according to Mr. Lister, that which is always seen in the blood out of the body.

The *liquor sanguinis* undergoes important changes in inflammatory blood. Quesnay, Hey, Thackrah, Babington, and Grainger, have all observed that the quantity of fibrine in it increases; and Andral and Gavarret have shown that it may rise from 2½ per 1000 as high as 10 per 1000. This superfibrination of the blood probably results from waste or oxidation of the tissues, and its augmentation must not be looked upon as an increased development of nutritive power. It is, in fact, the consequence of changes taking place in the blood and parenchyma of the diseased part.

The proportion of albumen and of saline matter is somewhat below the natural standard, whilst that of the water is increased above it.

When inflammatory blood is drawn from the body, it *coagulates* more slowly than healthy blood; the coagulum also is harder and smaller, and the quantity of serum apparently greater. The surface of the coagulum is commonly covered by a tough layer of yellow fibrinous matter, the *buffy coat;* and its upper surface is depressed in the centre, having elevated edges, being *cupped*, as it is usually termed. By this "buff" and "cup" the practitioner commonly estimates the intensity of the inflammation; but it must be borne in mind that buff may occur in certain conditions of the system, as in plethora, or pregnancy, or after exercise, without the occurrence of inflammation; and that the tissue affected, rather than the severity of the inflammation, influences its quantity; thus, it is greatest when the fibrous or serous tissues, and least when the mucous or tegumentary, are inflamed. The cupped shape of the clot may likewise be owing, in some degree, to the kind of vessel into which the blood is received, being most evident in those which are rather narrow and deep.

These are the principal changes met with in the vessels and blood of the affected part; but it must not be supposed that the inflammatory process consists simply in these changes: the nerves and parenchyma doubtless exercise an important influence, the precise nature and extent of which can scarcely at present be appreciated, though the observations of Paget, Wharton Jones, and Lister, demonstrate its existence; and indeed the researches of Mr. Lister on the pigmentary system of the frog's web have shown that in inflammation the tissues of the part—which he regards as the primary seat of the affection—are in a state of diminished functional activity; indeed, that the tissues of an inflamed part approximate to the condition of dead matter; "or, in other words, have suffered a diminution of power to discharge the offices peculiar to them as components of the healthy animal frame."

Symptoms of Inflammation.—These are *local* and *constitutional*. In order that they should occur, so as to establish the existence of the inflammatory process, it is necessary that the actions constituting it continue for some length of time; as they gradually pass from determination and congestion into inflammation, it is difficult to say, except by the persistence and intensity of the symptoms, that the physiological state has ended and the pathological one commenced.

The *local signs* of inflammation may be referred to five heads; viz., 1. *Alteration in Color;* 2. *Alteration in Size;* 3. *Modification of Sensation;* 4. *Increase of Temperature;* and 5. *Modification of Function of the Part Affected.* Each of these conditions may occur separately, or two or more be associated together, without the existence of inflammation; but it is the peculiar grouping together of them all that characterizes the presence of the pathological condition.

The relative intensity of these changes varies greatly, according to the tissue which is the seat of the inflammation; thus, in inflammation of mucous membranes and of the skin, the alteration in color is most marked; in inflammation of the

areolar tissue, the change in size always attracts special attention; and when a fibrous tissue is inflamed, its sensibility becomes greatly increased.

1. *Alteration in color* is an invariable and one of the earliest and most striking local signs of inflammation; parts that are naturally perfectly pale, as the ocular conjunctiva, assuming the most vivid crimson color when inflamed. Some parts, though they change in color, do not become red. Thus, the iris, when inflamed, assumes a grayish or brownish tinge; and the mucous membrane of the bladder, and of a portion of intestine, often becomes slate-colored. The redness of inflammation varies from a bright crimson to a dull purple, the tint depending greatly upon the state of the constitution, and upon the presence of more or less congestion. The duller and darker the tint the more local congestion or constitutional depression do we usually find. The redness is evidently due to the increased quantity of blood in the inflamed structure; and in the earlier stages of the disease, it is owing to the increase of the size of the vessels, the admission of new red corpuscles by which they are distended, and the draining away of the plasma. In some low or asthenic forms of the disease, the coloring matter of the blood appears to undergo changes that allow its ready transudation through the walls of the vessels; and in more chronic cases the vascularization of the products of inflammation tends to render the coloration more permanent.

2. *Alteration in size.*—Dilatation of the vessels being an essential element of the inflammatory process, swelling must be an invariable accompaniment of this disease. In the early stages this is due to the dilatation of the vessels; in the more advanced conditions, chiefly to the occurrence of effusions of various kinds.

The swelling varies greatly in different localities. It is greatest in those which are of a loose texture, and least in those which are firm and dense. Thus, for instance, in inflammation of the areolar tissue of the scrotum, the swelling is much greater than in the same disease affecting the testes. The inflammation of the conjunctiva occasions great swelling, that of the sclerotic but little.

The swelling of chronic inflammation may terminate in permanent hypertrophy, or thickening, partly in consequence of persistent dilatation of the vascular system of the part, but chiefly from the deposition of plastic matters in the substance of its tissues.

3. *Modification of the sensibility of the part*, owing partly to increased sensibility of the nerves, but chiefly to the pressure exercised on their terminal branches by the dilated bloodvessels, manifests itself by the occurrence of pain, or by some alteration in the special nervous sensibility of an organ; thus, in the eye, by the patient perceiving flashes of light, and in the ear, by noises of various kinds; in the bladder, by a constant desire to expel the urine; and in inflammation of the kidney, by a desire to urinate.

Pain is one of the most prominent symptoms of inflammation, and its existence serves a useful purpose by preventing the patient from using or moving the inflamed part. The intensity of the pain depends more upon the structure affected than on the violence of the inflammation. As a general rule, it may be observed that the intensity of the pain is in the inverse ratio of the swelling of the part affected. Thus, the pain of inflamed bone or fibrous tissue is excessive; that of areolar membrane, trifling. In erysipelas of the scalp, most pain is experienced in the ears; the pain of the inflamed sclerotic is far greater than that of a conjunctiva similarly affected. In some forms of inflammation pain can scarcely be said to exist, though the disease may assume the most destructive form. Thus, in certain inflammatory affections of the throat and of the peritoneum, there is little or no pain.

The character of pain varies according to the seat of the inflammation. Thus, when mucous membranes suffer, it is often of a gritty, itching, or burning character, as in conjunctivitis; when the serous membranes of the chest or abdomen are attacked, it is of a lancinating or stabbing character; aching in bones; throbbing when pus is about to form; sickening when the testis is affected. Inflammatory pain is always increased on pressure; when it is principally produced by pressure, the part is said to be *tender*. This tenderness is of great service in a diagnostic point of view; it may be elicited by direct pressure upon the part, as by squeezing an inflamed testis, or by pressing two surfaces together, as in an inflamed joint. In inflammatory pain, especially of osseous and fibrous tissues, there is very commonly nocturnal exacerbation.

It is important to bear in mind that inflammatory pain is often not seated merely

in the part affected, but radiates extensively along the course of the nerves, the terminal branches of which are implicated to a limited extent perhaps. Thus, in inflammation of the testis there is pain in the loins and groins. In deep-seated ophthalmia there may be exquisite pain along the branches of the fifth nerve over the whole side of the head or face, in consequence of the ciliary branches of the nasal, which are distributed to the iris and choroid, becoming compressed or stretched.

4. The *temperature* of an inflamed part usually rises above its normal standard. Hunter has, however, remarked that it does not increase above that of the left ventricle; thus, in a case of hydrocele, he found the tunica vaginalis at 92° Fahr. before inflammation had been excited in it, and at 98¾° after it had been set up. In a case of extravasation of urine, with severe inflammation, I found the temperature in the incision made in the perinæum 98° Fahr. It is probable that there is always a local increase of heat in inflammation. This, however, appears to the sensations of the patient to be far greater than it is in reality. Travers truly remarks, "that the nerves measure the sensation, and not the degree of heat." In many cases the sensation of the patient is that of *burning* in the part, though the actual rise in temperature may be but trifling. This is owing to the exalted sensibility of the nerves.

The cause of the increase of temperature is interesting. In all processes in the economy in which determination of blood takes place, as in blushing or parturition, the temperature rises. This can clearly not be owing to any production of heat during respiration, which may account for the *general* heat of the blood, but not for its *local* increase. It is more probable that, as the ordinary and general supply of heat is derived from the waste of the tissues, so that of inflammation may be due to increased destruction of organic matters in the part inflamed.

5. *Modification of function, use, or nutrition*, invariably occurs in inflammation, and furnishes important local symptoms. The *functional activity* of an organ is increased, in the earlier stages at least of inflammation; and the character of the secretions from the part is materially modified. Thus, when the mucous membrane of the urethra is inflamed, there is copious discharge from it; and this is not mucous, but purulent.

The *use* of the part affected is greatly interfered with; thus the bladder can contain no urine, the eye cannot bear the light, nor can a joint be moved, when inflamed.

The *nutrition* of the inflamed tissues is modified or arrested; hence, wasting, softening, or contraction, are common accompaniments of inflammation.

Constitutional Symptoms.—The severity of the constitutional symptoms will depend on the intensity and the extent of the inflammation; on the vital importance of the part affected by it; on the amount of local irritation; and the origin of the inflammation from external or internal causes. Thus, a moderate degree of inflammation in a part of no vital importance, as the skin, and occasioned by an external cause, as an abrasion, gives rise to no appreciable constitutional disturbance. But if the inflammation be wide-spread, as that of diffused erysipelas; or if it arise from constitutional causes; or if there be much local tension, as in whitlow; or if the part affected be of great importance, as the larynx or the eye, then the general symptoms become proportionally severe.

The constitutional disturbance in inflammation always assumes the form of fever —*inflammatory* or *symptomatic fever*, or *pyrexia*. Although the blood may previously have been in a diseased state, and so have predisposed the patient to the occurrence of an inflammation, the inflammatory fever is invariably secondary, being consecutive to the local affection. It is the true *surgical* fever, no febrile disturbance occurring in surgical practice except as a consequence of, and secondary to, local disease or injury. This fever appears to result primarily from deterioration of the blood, occasioned by the products of the rapid waste of the tissues that are the seat of the local disease—the inflammation—being poured into it more quickly than they can be eliminated by the different emunctories of the system, and thus accumulating in the blood. This deteriorated blood becomes a source of irritation to the vascular and nervous systems; and the attempt at elimination of the effete matter with which it is charged, occasions congestion and disturbance of function of the different excretory organs. Andral states that increase of the fibrine of the blood in inflammation is the result of the waste of the tissues locally affected; that this is simultaneous with the accession of the fever; and that, when once this increase of fibrine has taken place, the spread and intensity of the inflammation are

increased by it. He has further observed, that in inflammation without fever there is no increase of fibrine; and that, when the fever ceases, the proportion of fibrine falls to its normal standard. Thus, the local inflammation occasions the superfibrination of the blood, and this the general fever.

Inflammatory fever, or pyrexia, presents, however, an infinite variety of forms; the type which it assumes being finally dependent, 1st, on the state of the blood; 2d, on the condition of the nervous system; and, 3d, on the occurrence of certain local or specific symptoms dependent on the seat of the inflammation. These varieties in the type of the fever arrange themselves practically into three classes: 1. *Sthenic*, or typical inflammatory fever; 2. *Asthenic*, or typhoid fever; 3. *Irritative*, or nervous fever. In all these forms of fever there are three distinct stages; those of invasion, exacerbation, and decline. In practice, the recognition of the type or form that the constitutional fever of inflammation assumes is of the first consequence. The treatment of the patient, irrespective of the topical means that the special local affection may require, being altogether determined by the particular form that the concomitant constitutional disturbance assumes, it cannot be too sedulously borne in mind that the local signs, "the redness, swelling, heat, and pain," do not in themselves comprise all the morbid phenomena of an inflammation; there is always concomitant constitutional disturbance, sometimes preceding or predisposing to the development of the local signs, in all cases modifying their characters, and invariably, whether pre-existing or not, increased by the excitation of the local disease. It is the character of this constitutional disturbance or fever that will at last determine the kind of treatment to be adopted; and it consequently requires to be closely studied.

1. The *sthenic* form of inflammatory fever, true pyrexia, occurs in individuals of healthy constitution, young or middle-aged, in connection with those forms of inflammation that are of an active, acute character, and not unfrequently consequent upon injury.

In this form of fever the stage of invasion is very slightly marked, though it always occurs. There are rigors, with some slight depression of the nervous system; but these symptoms may be so transient as to escape observation entirely, and speedily terminate in the stage of febrile reaction. In the majority of cases, it is not until the constitutional disturbance has reached this stage that it attracts attention. The skin is now hot and usually dry; the pulse full, bounding, or thrilling, and quickened by thirty or forty beats in the minute above its normal rate; its character depending greatly on the tissue or organ affected. If this be the mucous membrane, skin, or a glandular structure, as the testis or mamma, the pulse is compressible, though full; if a serous membrane be inflamed, it is small, incompressible, and wiry; if a fibrous tissue be the seat of disease, it is hard and full. The secretions are arrested or diminished in quantity; hence the urine is high-colored and acid, the bowels are confined, the tongue coated with a white fur, and the mouth clammy, usually with much thirst; there is a feeling of great languor, and the head is often heavy and hot.

As the fever declines, if a favorable termination occur, the system not uncommonly relieves itself by a critical evacuation: from the skin, by abundant acid perspiration; from the kidneys, by the free deposition of lithates in the urine; from the bowels, by diarrhœa; and from some of the mucous surfaces, by hemorrhage. The tongue cleans, the pulse subsides in frequency and strength, the secretions become freer, the thirst lessens, and strength and appetite return. Should the fever not take a favorable course, death may ensue by the occurrence of serious visceral complications; the lungs and brain being especially apt to suffer, becoming the seats of fatal inflammatory mischief; or the sthenic form of the disease may gradually merge into those types that are characterized by debility and irritation.

2. The *asthenic* form of inflammatory fever principally occurs in those individuals whose constitutions are broken by privation, dissipation, or by any of the general depressing causes of disease, as grief, anxiety, or long residence in a vitiated atmosphere.

In constitutions such as these, so frequently met with in all classes, but especially amongst the poorer residents in large towns, inflammatory fever almost invariably assumes a low type. There is also, in this variety of the disease, a special tendency to its complication with visceral mischief; the lungs being peculiarly apt to become affected by a low or congestive form of pneumonia.

The asthenic form of the disease may come on as a sequence of the sthenic variety; the symptoms gradually merging into those of a low form, and being characterized by debility rather than by strength of action; the pulse becoming weaker though its frequency is kept up, the tongue becoming brown and dry, with a tendency to the early supervention of delirium of a muttering kind.

When the fever assumes the asthenic form from the very first, the period of depression is strongly marked, and often prolonged for many hours, reaction coming on gradually and imperfectly, alternating with the depression against which the system is struggling. Even when fully established, the symptoms of the stage of reaction are not of a very active character: there is throughout an appearance of heaviness or stupor about the patient, with little activity of the intellectual faculties, and an early tendency to delirium of a low form, especially at night; the pulse is feeble, though quick; the skin is either moderately hot, or else pungent and burning; the tongue brown and dry, with sordes rapidly accumulating about the lips and teeth; the cheeks are often flushed, and the eyes bright and staring. As the third stage comes on, if the patient recover, critical evacuations of a hemorrhagic or a diarrhœal character appear; the pulse subsides, the tongue gradually and slowly cleans from the sides and tip, and the patient slowly and imperfectly regains his strength; the convalescence being often interrupted by intercurrent disease, and the powers of the constitution being frequently broken for months, or for life. If the disease take an unfavorable course, the weakness of pulse and dark incrustation of tongue increase; the skin becomes cold; hiccup, subsultus, dyspnœa, or coma supervene; and death occurs from exhaustion, or as the result of visceral complication.

3. The *irritative* fever is of a less specific type. It is usually associated with the asthenic form, the nervous system being especially implicated. It occurs to individuals whose mental powers have been overwrought, or whose nervous systems have been irritated and shattered by intemperance. It is characterized by irregularity in its actions, by sudden exacerbations, and by a rapid decline. The several febrile symptoms run high in the early stages. The pulse soon becomes sharp and small; there are high delirium of a furious kind, wildness of eye, and heat of head. But these symptoms soon give way to signs of debility and exhaustion, and death takes place from coma and cerebral irritation.

Terminations of Inflammation.—There are two ways in which inflammation may terminate without leaving any traces of its presence in the part affected: these are by—1. *Resolution*, and 2. *Metastasis*.

1. The termination by *resolution* simply means a return to health. The pain and the heat first subside, the swelling lessens, and lastly the redness passes away: the constitutional symptoms also disappear. With regard to the more intimate changes in the part itself, it will be seen that the dilated vessels contract, and the stagnant masses of blood-disks are pushed on and broken up by streams finding their way into and against them. Absorption, which had been held in check during the continuance of inflammation, comes into play and removes the extravasated matters; and secretion becomes more active, and helps to unload the part. Resolution may in this way be complete; or it may go on to a certain point and then stop, leaving one or other of the effects that will immediately be mentioned.

2. By *metastasis* is meant a change in the seat of the inflammation—its sudden and complete disappearance from one part and reappearance in another. This is of extremely rare occurrence; it is occasionally seen, however, as in the inflammation of the testis that suddenly supervenes on the disappearance of a gonorrhœal discharge.

Besides these true terminations, inflammation commonly passes from the ordinary and primary condition into some other form of the disease. Thus, for instance, when plastic matter or lymph is thrown out, *adhesive* inflammation is said to have occurred; when pus is produced, we have *suppurative* inflammation; when an ulcer forms, *ulcerative* inflammation is said to have set in; and when the inflammatory action is of such intensity as to cause the death of the part affected, *gangrenous* inflammation has occurred. These different conditions of the inflammatory process vary so widely from its ordinary forms, and from each other, as to constitute distinct diseases, and as such to require separate and distinct consideration.

Extension.—When inflammation has once been set up in a part, it may extend to other portions of the system in four distinct ways.

1. *Local extension* may occur by the inflammation spreading along the tissue affected in its *continuity;* as, for instance, along the skin, areolar tissue, or mucous membrane.

2. Inflammation may also spread by *contiguity* of tissue, passing from one affected structure to an adjacent healthy one; thus we see the opposite surfaces of an inflamed joint involved in disease at opposed points.

3. Inflammation may extend to distant parts through the medium of the *blood;* this fluid being altered and depraved, and increasing the liability to inflammation in other parts, as in some of the erratic forms of erysipelas; or conveying pus to a distance, as in phlebitis, and thus giving rise to numerous centres of inflammation.

4. Inflammation may be carried to a distant part by *metastasis*, as has already been stated.

Effects of Inflammation.—Closely allied to the local symptoms of inflammation are the local *effects* of this disease. These consist, first, of changes in the consistence of the part inflamed, which may be of two kinds: *Induration*, chiefly as a consequence of chronic inflammation, occasioned by the turgescent state of the vessels of the part, or the effusion of plastic matter within it; and *softening*, chiefly after acute inflammation, depending partly on the infiltration of effused liquids into the textures, and partly on a disintegration of the substance, and thus a lessening of the consistence even of the hardest tissues, by impairment of their nutrition: thus an inflamed bone may be cut and pared down with a knife, or the ligaments of an inflamed joint become so soft as to admit of spontaneous dislocation. This softening may ultimately lead to the *interstitial absorption* of a part, which becomes shrunken and contracted after inflammation. *Ulceration*, as will hereafter be fully stated, is not an unfrequent consequence of this softening and atrophy conjoined with rigidity, as we see in those joints that have undergone inflammation.

In chronic inflammation we not unfrequently find that increased nutritive activity of the part leads to an *increase in its size and growth*, partly owing to actual augmentation in bulk of the tissues of the part; in many cases, however, being rather dependent on effusion into the areolar membrane.

Interstitial absorption and *gradual wasting* of a part, without previous softening, often occur as an effect of inflammation. Thus, a blow on the hip will occasion absorption and shortening of the neck of the femur.

Loss of transparency in structures that are normally translucent is a common effect of chronic inflammation, as may every day be observed in the cornea or in the capsule of the crystalline lens; in some cases this rather depends upon a modification of nutrition than upon the deposit of new matter upon the part. In other cases, again, it proceeds from the deposition of plastic matter in or upon it.

Varieties of Inflammation.—The symptoms, terminations, and effects of inflammation that have just been described, are those which characterize the more ordinary forms of the disease. In practice, however, we recognize many important varieties of this affection. These may be referred to three heads, as they affect its *duration*, its *intensity*, or its *character*.

1. *Duration.*—The disease may be acute or chronic, varying from a few days to many years, being especially persistent in those structures that are naturally least vascular, as, for instance, bones and joints.

2. *Intensity.*—When the symptoms are well marked, the redness and heat great, the tension considerable, and perhaps the pain severe, with corresponding constitutional disturbance, the inflammation is said to be *active* or *acute;* when of a less intense character, it is termed *subacute;* and when there are merely redness and swelling, with little or no pain, and but slight constitutional disturbance, the disease is said to be of a *passive* kind. The duration of the inflammation commonly influences its intensity, which is usually less in the more chronic cases; but very frequently we find the reverse, and when of but short duration it may be subacute or passive, whereas some forms of a very chronic character may retain great activity, and are especially liable to recurrent active attacks.

3. *Character.*—If the inflammation be circumscribed, occurring in a healthy constitution, and tending after a moderate time to terminate in resolution, it is called *healthy* or *phlegmonous*. If the vessels become distended and dilated, the blood circulate slowly, the redness be of a purplish tinge, and the swelling considerable, with but little heat, the disease is said to be *congestive*. Of *unhealthy* inflammation there are numerous varieties: the *diffuse*, having a tendency to spread widely un-

checked; the *strumous*, modified by scrofula; and the *specific* inflammations that arise from special causes, and are frequently capable of self-propagation.

Causes of Inflammation.—The causes of inflammation may be divided, like those of all other diseases, into *predisposing* and *exciting;* and these again may either be of a strictly local character, or may act locally through the medium of the constitution.

Local Predisposing Causes.—Though every tissue of the body is susceptible to inflammation, yet some parts are more liable to it than others. This cannot be owing to any greater degree of vascularity; for we find that the tissues lining the interior of a joint more readily and more violently inflame, though they are almost extravascular, than a portion of the mucous membrane, which is so abundantly supplied with vessels. Indeed, serous and synovial membranes are more liable than most other tissues to inflammatory excitement. Whatever the reason of this may be, there are two sets of causes that more especially predispose tissues to inflammation.

Thus, habitual overuse or overstimulation of a part, by producing determination of blood to it, may readily drive it into inflammation.

When a part, having once been the seat of inflammation, has been left in a weakened or impaired state, it will be more liable to the occurrence of a second attack of inflammation, having less resisting power; hence, also, subsequent attacks are induced by less active exciting causes than were required at first to call the disease into action; we see this in the inflammatory affections of eyes and joints. Then, again, a tendency to local congestion or stasis will dispose to inflammation, very slight overstimulation inducing the disease when the vessels of the part are already overloaded; this is often seen in the case of varicose veins, the congested skin readily running into inflammation.

Constitutional Predisposing Causes.—It is of great consequence to ascertain whether any constitutional predisposition to inflammation exists; and if so, what its precise nature is; for the progress of the local affection will in a great measure be dependent on the amount of constitutional predisposition. The constitutional predisposing causes are of two kinds.

1. Inflammation is predisposed to by a state of general *overstimulation of the vascular and nervous systems.* This condition may be hereditary, as in the sanguine temperament, or dependent on youth or sex; or it may be acquired by habitual indulgence at table: the induction of plethora and gout giving rise to a habit of body that is peculiarly favorable to the development of inflammation. Inflammations occurring in this habit of body are usually of the sthenic variety, though not unfrequently accompanied, in the case of persons accustomed to alcoholic stimulants, by fever of an irritative form.

2. A directly opposite condition of the system equally disposes the person to inflammatory attacks. Thus a state of *vascular and nervous depression*, by lessening the reacting power of the constitution, causing a loss of tone in the vascular system with ready tendency to congestion of the vessels and to stagnation of blood, disposes to inflammation. In this way inflammatory actions are especially apt to occur in scrofulous patients, in whom the general powers are enfeebled; and in such individuals they occur under the influence of exciting causes less in degree than those which affect persons in whom nutrition is more actively carried on. Here inflammation usually assumes the passive, congestive, or asthenic forms.

Exciting Causes.—These are very numerous and simple in their action. Commonly, *mechanical injuries* are those that occasion surgical inflammations; which are, indeed, set up by nature as the means of repairing the effects of the injury.

Chemical agencies, as the application of caustics and undue extremes of heat and cold, are also amongst the most common exciting causes. The application of the virus of certain *morbid poisons*, as of syphilis and the malignant pustule, directly occasions it. And lastly, certain *states of the blood* give rise to it, as we observe in those conditions of the system in which boils, carbuncles, &c., are produced.

An inflammation will often, though not necessarily, vary greatly in character according as it arises from a constitutional or a traumatic cause. When an inflammation of an organ, as of the lung, arises from an idiopathic or constitutional cause, a predisposition must previously have existed in the system, leading, under the influence of slight variations of external circumstances, as exposure to a draught of cold air or to wet, to the development of the local disease. The inflammation

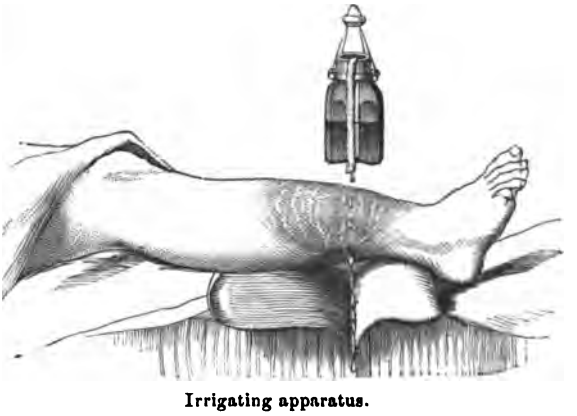
will, therefore, usually be prone to become wide-spread, and frequently has a tendency to assume a low type. In the case of a similar inflammation, as of the lung, following an injury, as a wound of the organ, in an otherwise perfectly healthy subject, the disease will be localized in the seat of injury; having little tendency to spread, and usually affecting the active sthenic character. If, however, the constitution be in a bad state, and the blood unhealthy, or if the patient be exposed to unfavorable hygienic conditions, a very slight injury may develop a wide-spread inflammation, which will then always assume a low form, and usually an erysipelatous character.

Treatment of Inflammation.—The treatment of inflammation may be divided into the *preventive* and the *curative*.

The *preventive treatment* can be employed only in inflammations supervening on injury. In it the principal point to be attended to is, the removal of the local and constitutional causes of irritation. By doing this, the occurrence of inflammation in a part that has been injured or otherwise disposed to its accession may be entirely prevented, or, if this be not accomplished, much lessened in severity.

The *local preventive* treatment of inflammation is best carried out by the removal of all sources of irritation, by absolute rest of the part, and by the free application of cold. If the injury be superficial, and not very severe, lint dipped in cold water, frequently renewed, may be applied; or, if the skin be unbroken, an evaporating lotion may be used. Should a limb or joint be severely injured, cold irrigation will be a preferable mode of reducing its temperature. This may most conveniently be done by suspending over the part a large wide-mouthed bottle, full of water, in which a few pieces of ice may, if necessary, be put; one end of a skein of cotton, well wetted, is then allowed to hang in the water, whilst the other is brought over the side of the bottle. This, acting as a siphon, causes a continual dropping upon the part to which the cold is to be applied (Fig. 52). In some cases the application of pounded ice in a bladder, or of cold evaporating lotions, may be preferred to the irrigation. Dry cold may be advantageously substituted for the moist in many cases. It has the advantage of not soddening the skin, and is less likely to be followed by gangrene, which may result in consequence of the too incautious or long-continued use of cold and moisture. The dry cold is best applied by putting pounded ice into a thin vulcanized India-rubber bag, as recommended by Esmarch.

Fig. 52.



Irrigating apparatus.

At the same time all constitutional irritation must be removed by abstinence, rest, and a free aperient.

[A very convenient and efficient method of applying either dry cold or dry heat, is that described by M. Petitgand under the name of "mediate irrigation." This surgeon employs tubes of vulcanized India rubber, sixteen or twenty feet in length, and about half an inch in diameter, the thickness of the tube wall usually not exceeding a single line. These tubes may be applied to a limb like a simple spiral bandage, being retained in place by a few turns of a roller, or they may be coiled into any shape that may be required for application to a joint, to the head, or to the female breast. The tubes can be readily kept in position by a few strips of bandage made to pass alternately above and below the contiguous spiral coils. The tube acting like a siphon, a continuous current of water of any given temperature can be made to pass over or around any part of the body, without the annoyance of wetting the pillows or bedclothes, and other evils which are inseparable from the ordinary methods of irrigation.—*Recueil de Mém. de Médecine, de Chirurgie, et de Pharmacie Militaires*, Déc. 1866, p. 506.—A.]

In undertaking the *curative treatment* of inflammation, the surgeon must not

allow himself to be guided by the name of the affection with which he has to do, but he must be influenced in the means that he adopts by the constitutional condition of the patient, by the type of the inflammatory fever, and by the state of the diseased part; for nothing presents greater variety than the management of the inflammatory process in different conditions of the patient, and in the different phases of that affection. We shall accordingly consider the treatment of inflammation as applied to the acute and sthenic, the asthenic and irritative, and the chronic varieties of the disease.

Treatment of Acute Inflammation with Fever of the Sthenic Type.—In the treatment of this variety of the disease, active and energetic measures must early be had recourse to, especially if the patient be young and strong. There is no affection that is more under the control of the surgeon than this when occurring in a healthy constitution, and in which more can be done by active means early employed. It is consequently of the first importance that precious time be not lost by the employment of inefficient measures; otherwise important local changes and irremovable alterations of structure may ensue. It is also of great consequence to remove the disease fully; not only to subdue it, but to extirpate it, lest it degenerate into some of the more chronic, passive, and intractable forms.

The first thing to be attended to in the treatment of the sthenic, and of all the other varieties of inflammation, is the *removal of the cause*. Thus, rest must be afforded to a diseased joint, light removed from an inflamed eye, and a foreign body taken out of the flesh in which it is lodged.

The next great indication is to lessen the determination of blood to the part. The measures for accomplishing this comprise what is termed the *antiphlogistic* treatment. This consists of constitutional and local means.

Constitutional Treatment of Acute Inflammation.—The most powerful and efficient means that we possess is certainly *bloodletting;* and, when the inflammation is sufficiently extensive and severe, and the patient's powers warrant it, we may have recourse to the abstraction of blood. But, as blood can easily be taken away, but cannot readily be restored to a patient, we should never remove it unnecessarily, lest permanent ill effects to the health ensue. Bloodletting is certainly not often required in the treatment of surgical inflammations; and it should be especially avoided in very young and in very old subjects; in the inhabitants of large towns generally; or in those in whom inflammation of a specific character occurs: hence in hospital or in private practice it is now often found advisable to have recourse to other means in its stead. It should never be had recourse to unless an organ of great importance to the economy, as the lung or brain, for instance, be inflamed, or so injured that inflammation of it is imminent; or unless a tissue, like the transparent structure of the eye, be affected, in which it is absolutely necessary, at any risk, to cut short an inflammation before it gives rise to change of structure, which, however slight, would be fatal to the utility of the part. The quantity of blood that should be taken necessarily varies greatly, according to the age and constitution of the patient, and the nature of his disease; and it is of importance to bear in mind that, when bloodletting is required, the system tolerates the loss of the vital fluid in a way that it does not otherwise. The effect produced on the pulse and on the system should be the guide to the quantity to be taken away. A decided impression should be produced by bloodletting, not so much on the frequency of the pulse, as on its character; *that* should guide us, and not the number of ounces drawn. The point to be obtained is the greatest effect upon the system with the least loss to the patient; hence the blood should be taken from a large orifice in the median basilic or the cephalic vein, the patient sitting upright. In repeating the venesection, we must be guided by the impression that has been made upon the disease, and by the state of the pulse. By bloodletting, when it is indicated by the severity of the inflammation, or by the importance of the part affected, we not only lessen the force of the circulation, but we also abstract at once from the system a quantity of blood that has been deteriorated by an accumulation of the products of the waste of inflamed tissues in it. It is especially in those forms of inflammation, therefore, in which the blood is early and abundantly charged with these products, in which it is superfibrinated to a great extent, as in inflammation of serous membranes and of fibrous tissues, that bloodletting has been proved by experience to be of service.

Whether bloodletting be had recourse to or not, we must endeavor to set the

secretions free, and in this way to clear the blood of the morbid products accumulated in it. If we can bring about a full action from the liver or bowels, with copious bilious evacuations, abundant secretion of acid perspiration from the skin, or a copious discharge of urine loaded with lithates, we shall often at once cut short the disease. With these views, *purgatives*, *diaphoretics*, and *diuretics* are to be administered.

Purgatives should always be given early, except in some special cases of acute inflammation of the abdominal organs. They clear the intestinal canal, free the secretions and equalize the circulation. In general, it will be found most advantageous to administer a mercurial, followed by a brisk saline purge; and this should be repeated from time to time during the progress of the case.

Diuretics and *diaphoretics* require to be administered frequently during the day. If the skin be hot and dry, antimonials should be given in small and repeated doses; these may advantageously be conjoined with, or replaced by salines, such as the citrate of potass, the acetate of ammonia, or nitre. In this way the force of the heart's action is lessened, and the skin and kidneys are called into active operation. It is also probable that the salines alter the constitution of the blood, dissolving the fibrine and lessening the quantity of water, both of which constituents are in excess in inflammation.

In many forms of sthenic inflammation, especially in those which affect the serous and fibrous membranes, we do not possess a more efficient agent than *mercury*, administered, not as a purgative, but as an alterative to the system. And I confess that I can in no way give my adherence to the doctrines of those who, disregarding the daily evidence of professional experience, deny the utility of the preparations of this mineral in the treatment of inflammatory disease. Mercurial remedies are of special service in aiding the operation of other medicines. Diuretics, diaphoretics, and purgatives, will frequently not act properly unless conjoined with a mercurial. In inflammation the preparations of mercury act as direct antiphlogistic agents, lessening the quantity of fibrine in the blood, and equalizing the circulation. They are of especial value in promoting the absorption of exudation matters, more especially of lymph, as we may see happening under their influence in certain diseases of the eye. They appear to do this rather by lowering the vascular action of the part, and thus allowing the absorption to be carried on, which had been arrested during the persistence of the inflammation, than by any specific influence exercised over the effused fibrine. Care, however, is required in the administration of mercury. In irritable or cachectic constitutions it should not be given at all, or not without great caution. It is best borne by strong constitutions, and in acute inflammation of the serous and fibrous tissues.

Calomel, blue pill, and mercury and chalk, are the preparations usually employed when the mineral is given by the mouth. When it is administered endermically, the mercurial ointment is preferred; and the use of the mineral is in general continued until the gums become spongy, and a red line is formed at their edge; the patient experiencing a coppery taste in the mouth, and the breath becoming fetid. It is not necessary to induce profuse salivation.

It is especially the combination of calomel with opium that produces the most beneficial effects in the treatment of active surgical inflammation. Two grains of calomel, and half a grain or a grain of opium, or five grains of Dover's powder with three of mercury and chalk, every fourth or sixth hour, tranquillize the system and lessen vascular action in a remarkable manner, especially in acute inflammation affecting the jaws, the eye, or the serous membranes.

Opium is not only of use in the way that has just been indicated, but is of essential service in allaying the pain and irritability that often accompany inflammation, especially in many inflammatory affections of the bones and joints. In the form of Dover's powder, it is of especial value in this respect.

In the treatment of acute inflammation, it is of essential consequence that the patient should be kept at rest, in a well-regulated temperature, and on low diet; in fact, the more complete the abstinence in this respect is, the more rapidly do therapeutic means act and the febrile symptoms cease.

Local Treatment of Acute Inflammation.—This is of the utmost importance, as it directly influences the tissues and vessels that are deranged in action. It consists of means of the most varied and opposite characters. Heat and cold; iced water and hot fomentations; astringents and sedatives—are all employed, and

all with success, but each only in certain stages and forms of the disease; and the art in conducting the local treatment of inflammation consists in adapting the various means at our disposal to the particular condition of the case before us.

Local bloodletting is the most efficient means we possess in directly lessening vascular action in a part, as by it we take the blood directly from the inflamed and turgid vessels. It may be used in addition to, though it is now very commonly employed in preference to, general bloodletting: especially if the inflammation be not severe, or if it occur at either of the extremes of life, in women, and in persons generally of feeble power.

Blood may be taken locally by *punctures*, *scarifications*, or *incisions*, or by *leeching* or *cupping*.

Punctures and *incisions* can only be practised in inflammation of the cutaneous and exposed mucous surfaces, due attention being had to subjacent parts of importance. They constitute a very efficient means of relief to the part, as not only is blood removed, but an exit is afforded for effused matters; tension is consequently materially lessened, and the tendency to sloughing and other evil after-consequences perhaps prevented. The removal of the tension of inflamed parts is not only of the greatest advantage locally, but is of considerable service to the system at large by lessening the pain and general irritation that are always occasioned by it. The punctures should be made with a fine lancet, in parallel rows over the inflamed surface, and should not exceed a quarter of an inch in depth. The incisions must always be made in the axis of the limb, and should be so arranged as to afford the greatest possible relief to the tension of the parts. Their extent superficially and in depth must vary according to the seat of the inflammation. Thus, in the inflamed conjunctiva they must of course be very limited, whilst in phlegmonous inflammation of a limb they may be of much greater extent. Care, however, must always be taken not to wound superficial arteries or veins. A modification of puncture is sometimes practised by opening the veins in the neighborhood of the inflamed part at several points at once. Thus, in inflammation of the testis the scrotal veins may advantageously be punctured. The bleeding from punctures and incisions should always be encouraged by warm fomentations.

Leeches are usefully applied to the neighborhood of inflamed parts, but should not be put upon the inflamed surface itself, as their bites irritate. There are certain situations in which leeches should not be placed, as over a large subcutaneous vein, or in regions where there is much areolar tissue, as the scrotum or eyelids, lest troublesome hemorrhage or ecchymosis result. So, also, they should not be applied near a specific ulcer, lest their bites become inoculated by the discharge. The bleeding from a leech-bite should be encouraged by warm poulticing or fomentations for some time after the animal has dropped off. In this way from half an ounce to an ounce of blood may be taken by each leech. There is usually no difficulty in arresting the hemorrhage from the bite; should there be any, continued pressure with some scraped lint, felt, matico, or powdered alum, will accomplish this. If this do not succeed, which may happen in some situations where pressure cannot be conveniently applied, as on the neck and abdomen, particularly in young children, a piece of nitrate of silver scraped to a point, or a heated wire introduced into the bite, previously wiped dry, or a twisted suture over and around it, may be required.

Cupping is the most efficient local means of removing blood that we possess, and the quantity extracted may be regulated to a nicety in this way. It cannot, however, be employed upon the inflamed surface itself, on account of the pain and irritation that would be occasioned, and is consequently chiefly applicable to internal inflammations. As the scars made by the scarificators continue through life, cupping should not be practised upon exposed surfaces.

In *cold* and *heat* we possess two most important local means of controlling inflammation. They cannot, however, be employed indiscriminately.

Cold.—There are two stages of inflammation in which cold may be employed with especial advantage: first, during the very early and acute stage, rather with a view of preventing or limiting the inflammation, so that it may not pass beyond the bounds of adhesive action; and next, when acute inflammation has passed off, the vessels of the part remaining relaxed and turgid: the application of cold acting as a powerful agent in restoring the tone of the parts.

Cold should never be had recourse to between these stages, when suppuration is coming on, or has set in; still less should it be employed when there is a tendency

to mortification. Its long-continued and incautious use may indeed be followed by profuse suppuration or extensive sloughing of the inflamed part.

The modes of applying cold vary according to the part affected and the stage of the inflammation. In the early and acuter stage, and if the surface be inflamed, evaporating spirit lotions, to which sedatives may sometimes be advantageously added, are the best. If it be wished to influence the whole substance of a limb, irrigation with cold water should be adopted (Fig. 52). If it be intended that the effect of the cold penetrate deeply, as in inflammations of joints, of the head, spine, or chest, it may be applied by means of pounded ice. The ice is best applied by being placed in a bladder, gut, or a Mackintosh bag, partially filled. Dr. Esmarch has especially pointed out the great advantage of using ice in an India-rubber bag, which always remains dry, and from the use of which no danger from frost-bite is to be apprehended, as may occur from the long-continued use of cold and wet applications. With the view of removing the congestion consecutive on inflammation, cold douching or sponging is most efficacious.

Warmth and *moisture* conjoined are of the utmost service in the treatment of inflammation during the height of that process—during that period when cold applications are not admissible. By these means, tension is relaxed, effusion is favored, and thus the over-distended vessels are relieved. If continued for too long a time, however, these means favor congestion, and sodden the parts. Warm applications are especially serviceable in all cases of inflammation attended by much pain, more particularly if this occur from tension; and they are especially useful when suppuration is threatening, or has come on, and in many cases where there is a tendency to slough.

When abscess threatens, or the surface is broken, nothing affords so much relief as a well-made poultice, either of linseed-meal or of bread; this, made soft and smooth, and not spread too thickly on the cloth containing it, should be applied as hot as the patient can bear it.

Water-dressing, consisting of doubled lint, well soaked in tepid water, and covered by oiled silk, or thin gutta-percha, extending from half an inch to an inch beyond it on all sides, may be advantageously substituted for a poultice, if the sore be small, and the inflammation limited.

Fomentations of warm water, or of decoction of poppy and chamomile flowers applied by means of flannels wrung out of these liquids, or of bags containing the boiled plants, well soaked in the decoction, squeezed out, and applied hot are very useful in extensive superficial inflammations. The flannels and bags should be well covered with oil-silk or Mackintosh cloth, so as to retain the heat, and to prevent evaporation. Spongio-piline may be used as a substitute for ordinary fomentations in cases in which the surface is unbroken.

Position.—The inflamed part should always be placed in such a position as to facilitate the return of blood from it. Unless this be done, the pain is greatly increased, and the congestion augmented. Hence the part requires to be elevated on a level with, or above, the rest of the body. All motion and use must likewise be interdicted, as favoring determination and increasing pain.

These are the means by which acute active inflammation is arrested and cured. In their employment, we must endeavor to proportion the activity of our measures to the age, constitution, and vigor of the patients, and to the seat and intensity of the local disease; and must continue the treatment until the inflammatory action is not only arrested, but has entirely subsided, the part being restored to its ordinary healthy state.

Treatment of Acute Inflammation with Constitutional Symptoms of the Asthenic and Irritative Types.—Having now discussed the treatment of ordinary acute inflammation in its sthenic form, we must next say a few words on the management of the *asthenic* and *irritative* varieties of the disease. These forms of inflammation derive their peculiarities more from the character of the constitutional disturbance that accompanies them, than from any peculiarity in the local affection. Hence it is not in the topical treatment of the disease, but in the management of the constitutional condition, that the principal difference exists between these and the other varieties of inflammation.

In considering this part of our subject, it is of especial importance to banish the term "*antiphlogistic*;" for the same treatment that would arrest inflammation in one form of the disease, would certainly favor its progress in another. Nothing

appears to me to be more unscientific than to endeavor to treat all inflammations on one uniform plan. Surely the scoffers at medical science have some ground for doubting at least the wisdom of its professors, when they see one set of practitioners treating every inflammatory disease with depletion, antimony, and calomel, whilst others teach that the panacea for all inflammations consists in brandy, ammonia, and bark. It is impossible that both methods can be right, as exclusive plans of treatment. But the error lies in making them exclusive. Each is serviceable, and indeed alone applicable in its own particular cases. And between these extremes lie a multitude of forms of disease, in which endless modifications and combinations of these two methods of treatment—the stimulating and the depletory—must be adopted by the surgeon in order to meet the varying conditions of his patient. The local symptoms that constitute the inflammatory process, whether occurring externally or internally, in the conjunctiva or in the lung, are associated with constitutional disturbance that varies according to the age and the constitutional condition of the patient. It is the type that is affected by this constitutional disturbance, its sthenic or its adynamic character, as indicated by the pulse and by the tongue, and not the mere diagnosis of the local disease, that must guide the surgeon in the adoption of his line of practice. We may advantageously treat with antimony and bloodletting acute inflammation of the conjunctiva, or that which is the consequence of a wound of the lung, in an otherwise healthy and robust man of thirty; whilst in a broken man of seventy, ammonia, bark, port wine, and brandy would be equally proper; but if we were (except under peculiar and exceptional circumstances) to reverse this treatment—to stimulate the young or vigorous, and to deplete the aged or feeble—we should act contrary to common sense, and probably destroy rather than cure our patients. It is of far greater importance to be able to estimate accurately the true constitutional condition of the patient, than to be able to form a minute diagnosis of the precise seat, extent, and depth of the local mischief. It is a fatal error, too often committed, to attach too much consequence to the recognition of the local malady, and too little importance to the character of the constitutional disturbance attending it. The surgeon who acts thus runs the risk of treating the Name and not the Disease. If we treat erysipelas or pneumonia as mere affections of the skin or lung, on one uniform plan, without reference to the type of the constitutional disturbance accompanying them, we shall miserably err in a considerable proportion of the cases. But if, paying but little attention to the local affection, except so far as its characters indicate the general type of the disease, we make the constitution of our patient our guide, and deplete or stimulate according to the state in which we find it, and thus perhaps treat two patients with the same disease, so far as name is concerned, on totally opposite plans, we shall not act inconsistently, but in strict conformity to the natural condition of the patient and of his disease.

It may be stated, as a general rule, though doubtless one to which there are many exceptions, that the inflammations occurring in internal organs, as in the lung or brain, from direct and severe injury, are usually more acute, more active, and attended by constitutional symptoms of a more sthenic character than when the same organs are affected by inflammation arising independently of traumatic causes.

We must, then, be entirely guided in the means that we adopt by the condition of the patient, the state of the tongue and pulse, and the general character of the symptoms. If these from the first partake of the asthenic or irritative type, we cannot at any period have recourse to the treatment that has been recommended in sthenic inflammation. If the disease commence in an active form, the fever progressively assuming a lower and lower character merging into the asthenic and irritative types, so must we gradually alter the nature of our general treatment; and this is always a delicate procedure, requiring much caution. Though the inflammatory fever may at first assume the sthenic form, if there be reason to believe, from the broken constitution of the patient, or from the congestive or passive character of the local inflammation, that the constitutional symptoms will not long continue of this type, we must be extremely cautious how we lower the patient by active depletion; for, however high the fever may at first run (and in these cases there is often febrile disturbance of a very active character for the first few days), the disease speedily expends its force and rapidly subsides into a low form. In cases of this kind, which are of very common occurrence in London practice, more particularly in hospitals, we should never bleed, but content ourselves,

after clearing out the bowels, with keeping the patient quiet on a moderately low diet, and administering diaphoretic salines. As the symptoms gradually merge into the typhoid type, the pulse with increasing frequency diminishing in power, the tongue becoming dry and dark, and the other symptoms of asthenia beginning to show themselves, we must begin to give some stimulant in combination with the salines. The carbonate of ammonia in five or ten grain doses, or even more, may be given with bark, or in an effervescent form with fifteen grains of the bicarbonate of potass and a sufficient quantity of citric acid, every third or fourth hour. The nourishment must be increased; and wine or alcoholic stimulants must be conjoined with it, in proportion as the symptoms of debility become more and more urgent. In effecting this change, we must be careful not to run into the error of overstimulating our patient; this may be avoided by observing the influence exercised on the pulse and tongue by the change in treatment.

In the majority of cases, this stimulating plan is not well borne during the first few days after the setting in of an inflammation, especially if there be gastric irritation and sickness; but when the more active symptoms show a tendency to subside, when the bowels have been well cleansed out, and the skin is beginning to assume a slight degree of moisture, then it may be resorted to with every probability of success.

In many cases, however, it happens that the symptoms so rapidly sink into, or from the very first assume, so asthenic a character, that the only treatment which holds out a chance of saving the patient's life consists in the early and free administration of tonics and stimulants, with mild nourishment, such as ammonia and bark, wine, brandy, or porter, with beef-tea and arrowroot; and of these, large quantities may be required in the four-and-twenty hours, the patient evincing a tendency to sink whenever their use is interrupted. Although stimulants be freely administered in these cases, the food should be bland and capable of easy assimilation. It is worse than useless to give meat, &c., when the patient cannot digest it; but beef-tea, eggs, and farinaceous food, may be given in large quantities with advantage. The brandy-and-egg mixture of the pharmacopœia, if well made, combining nutriment and stimulus, is the best remedy that can be administered in many cases of low inflammation.

Under this plan of treatment the tongue will be found to become moist, the brown sordes to clear off from the inside of the mouth, the pulse to become steady and full, sleep to be procured, and the strength maintained. The more I see of surgical inflammation, the more confidence do I feel in this stimulating plan of treatment, which is the only method of carrying patients through those low forms of visceral inflammation that are so frequent in hospital practice. The liability to these inflammations will also be materially lessened by the early employment of a stimulating plan of treatment after injuries and operations.

As the asthenic passes into the irritative form, we may find it necessary to conjoin opiates with the general treatment.

In the low forms of inflammatory fever, congestive pneumonia and asthenic bronchitis frequently supervene. In this complication, the following draught may be advantageously given every third or fourth hour: ℞. Tincturæ camphoræ comp. ℥xx ad xxx; Ammoniæ carbonatis gr. v ad x; Decocti senegæ ℥iss. Rubefacients, blisters, or dry cupping may also be applied to the chest. The diarrhœa that not unfrequently occurs must be met with opiates and astringents; and if the urine cannot be passed, it must be drawn off by the catheter.

Treatment of Chronic Inflammation.—The treatment of chronic inflammation is far more difficult, and requires much more attention, than that of the acute form of the disease. Chronic inflammation is so frequently complicated with various unhealthy conditions of the system, and with an impaired state of general health, by which, indeed, it is often kept up, that much practical tact and skill are required in carrying out the therapeutic indications properly.

Constitutional Treatment of Chronic Inflammation.—In the treatment of chronic inflammation we have not only to subdue inflammatory action, but also to remove structural changes and other effects induced by it. Hence, our object is not to produce a great and sudden impression on the system, as we are often required to do in the treatment of the acute affection. It is not in this way that chronic inflammation can ever be cured, or its effects removed. The patient might be bled to death, and still the increased vascular action would go on in the inflamed part,

so long as there was a drop of blood circulating in his vessels. It is true that the same antiphlogistic means are employed in arresting the chronic as in cutting short the acute form of the disease, but in a less energetic manner; our object being to induce a gradual and continuous improvement in the state of the system and of the diseased part. Local nutrition is always modified in chronic inflammation; and it can only be restored to its normal condition by close attention to all the circumstances that tend to improve the patient's general health, as well as by producing an impression on the part itself by appropriate local means. Hence, in the treatment of chronic inflammation, hygienic measures are of the first consequence. In most cases, nothing can be done without proper attention to these; and much can be done by these that cannot be affected by any more direct medicinal means. The treatment of this form of inflammation must likewise be varied according as it is of an uncomplicated character, occurring in an otherwise healthy constitution, and assuming a sthenic type; or as it occurs in a cachectic and feeble system, assuming a congestive or passive character; or as it is met with in an unhealthy constitution, affecting a specific form.

In the management of these various forms of chronic inflammation the patient must be kept at rest, and, if the disease be at all extensive, confined to bed. He should be in pure air, and, as a general rule, be put on a light and unstimulating diet. The regulation of the *diet* is of much consequence, and the amount and quality of the nourishment afforded must be carefully proportioned to the age, strength, and previous habits of the patient, as well as to the degree and the seat of the inflammation, and the form of constitutional fever that accompanies it. In the more acute form of chronic inflammation, farinaceous slops, at most beef-tea, and light puddings, can be allowed. In the less active forms occurring in feeble constitutions, with depression of general power, animal food of a light kind may be given, and the scale of nourishment increased until stimulants, as beer, wine, or brandy, are allowed. Nothing requires greater nicety in practice than to proportion the diet, and to determine the cases in which stimulants are necessary. It may be stated generally that the more the disease assumes the asthenic and passive forms, the more are stimulants required; until, at last, in the truly adynamic type, our principal trust is in these agents, and large quantities of wine, brandy, and ammonia are required to maintain life.

Mercury is of essential service in the more active forms of chronic inflammation; but in all cachectic and strumous constitutions it should, as much as possible, be avoided. It is not only of great use in arresting the further progress of the disease, but especially in causing the absorption of some of the effusions that result from it, and in removing some of the other effects of chronic inflammation, such as thickening, hardening, and opacity of the parts. It should be given in small doses for a considerable length of time, until the gums are slightly affected. In many cases of depressed power it may be very advantageously conjoined with bark or sarsaparilla. The most useful preparations are calomel in half-grain or grain doses, and the iodide of mercury in the same quantities; or, if a gradual and continuous effect be required, the bichloride in doses from one-sixteenth to one-eighth of a grain.

Iodide of potassium is an alterative and absorbent of the greatest value, especially in chronic inflammations of fibrous or osseous tissues occurring in strumous constitutions. In these it may often be substituted with great advantage for mercury, and given in those cases in which that mineral would otherwise be administered. In many cases, it is of essential service after a mercurial course; some days should, however, be allowed to elapse after the mercury is discontinued before the iodide is given, otherwise profuse salivation or even sloughing of the gums is apt to result.

Sarsaparilla is a very valuable remedy if obtained good, and forms an admirable vehicle for the preparations of mercury or iodine. The fluid extract of red Jamaica sarsaparilla, carefully prepared, is that to which I give the preference; and where the inflammation is associated with want of power, its value is certainly very great.

Cod-liver oil is of the very greatest value in the various strumous forms of chronic inflammation in debilitated, emaciated, cachectic, and strumous subjects; it may be given in some vehicle, such as milk, orange-wine or juice, that covers its taste. In some cases it is advantageously conjoined with the iodide of potassium; or, when there is much want of power, and strumous anæmia is present, with the preparations of iron. It is more particularly in children and young people that it is of service in removing the various effects of chronic inflammation.

Purgatives are often required in chronic inflammation. In robust subjects in whom the disease is active, salines may be employed; to which, if there be a rheumatic tendency, colchicum may advantageously be added. As a general rule, warm aperients, such as the compound decoction of aloes, with Rochelle salt, answer best; and in children a powder composed of one part of mercury and chalk, two of carbonate of soda, and four of rhubarb, will be found very serviceable.

Local Treatment of Chronic Inflammation.—In chronic inflammation, our local means of treatment are much more varied than in the acute form of the disease.

Local bloodletting is often required with a view of directly unloading the vessels of the part; and this is accomplished by scarification, leeching, or cupping. Scarification is principally employed in chronic inflammation of the mucous membranes. Leeches may very usefully be employed, in some forms of chronic inflammation, by applying two or three at a time, and repeating this application every second or third day.

Warmth and *moisture* are not so serviceable in chronic as in acute inflammation, and care should be taken that they be not continued for so long a time as to sodden the parts. An astringent or stimulant, such as liquor plumbi or spirits of wine, may often advantageously be added to the warm application.

Cold is seldom required in any but the advanced stages of chronic inflammation, in which there are debility and passive congestion of the vessels of the part. In order to remove this state of things, its application should not be continuous, but should be made twice or thrice a day, so as to occasion a sudden shock, and produce a constringent effect upon the enfeebled circulation of the part. This is best done by pumping or pouring cold water from a height, or by douching, and should be followed by active friction with the hands.

Friction is often of great service in some of the forms of congestive inflammation, by the removal of the thickening, stiffening, and induration that result. Friction may be practised either with the naked hand, or with some embrocation of a stimulating or absorbent character.

Counter-irritants are amongst the most energetic local means that we possess for combating chronic inflammation. Rubefacients, in the shape of stimulating embrocations, to which absorbents, such as mercurial ointment, may often advantageously be added, are usefully employed as adjuncts to friction.

By means of *blisters* applied either directly over the inflamed part, or at a little distance from it, the surface being kept raw and exuding by some stimulating application, effusions and those chronic structural changes that accompany the more advanced stages of inflammation may be removed.

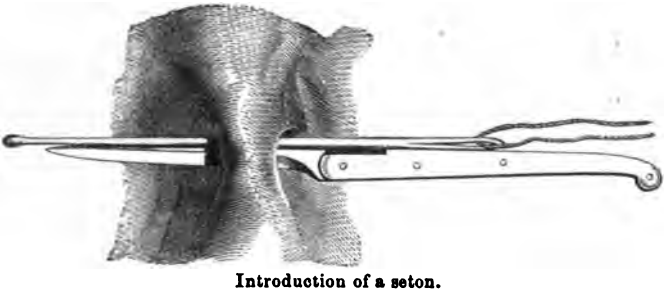
In the latter stages of chronic inflammation, the *pyogenic counter-irritants*—issues, setons, and the cautery—may be very advantageously employed. By these a powerful derivative action is induced, and chronic thickening may be melted away.

Issues are of especial service in chronic inflammation of the viscera, joints, and bones, before suppuration has taken place; they should be applied in the soft parts over the affected structures, and may be kept open for a very considerable length of time. They are best made in the following manner. A piece of common adhesive plaster, about two inches square, having a hole of the size of a shilling cut in its middle, is fixed upon the part where the issue is to be made; a piece of potassa fusa, of about the size of half a cherry-stone, is then placed on the surface left uncovered by the circular central aperture, a square piece of plaster being laid over all. The patient experiences a burning pain for about two hours, when it ceases; on removing the plasters, a black slough corresponding in size to the central aperture will be found. This must be poulticed for a few days, until it separates, and the raw surface then dressed with savine ointment, or stimulated by an issue-bead. Whenever it shows a tendency to heal, it may be kept open by an occasional application of the potassa fssa.

A *seton*, when counter-irritation is to be applied over very deep-seated parts, is more useful than an issue. The seton may most conveniently be made in the following way (Fig. 53). A fold of skin about two inches or more in breadth is pinched up, and its base transfixed by a narrow-bladed bistoury. The blunt end of an eyed probe, threaded with the seton, is next pushed along the back of the blade from heel to point, which being withdrawn as the probe is carried onwards, the seton is left in the wound. A poultice should then be applied.

The *actual cautery* is especially successful in deep-seated chronic inflammation, as of joints, when a deep and prolonged action is required to be set up. The cauter-

Fig. 53.



Introduction of a seton.

izing irons may be of various shapes. They should be heated to a dull-red heat, and then quickly drawn in lines, crossing one another, over the part.

Astringents directly applied to the inflamed parts are of extreme service in those forms of congestive or passive inflammation in which the circulation is sluggish and the capillaries loaded; they afford relief in these cases by inducing contraction of the vessels. In order to insure their proper action, they must be employed of sufficient strength; for if too weak they irritate, and increase rather than relieve the congested condition. The nitrate of silver is the astringent that is commonly preferred; and this, applied either solid, or in solution containing from ten grains to one drachm of the salt in one ounce of distilled water, will produce a very marked beneficial influence in congestive inflammation of the mucous and cutaneous surfaces.

Pressure by means of well-applied bandages, elastic webbing, or strapping, is of essential service in supporting the feeble vessels in congestive inflammations. In many cases pressure may be advantageously conjoined with absorbents and rubefacients, as mercurial and camphor liniments, or the plaster of mercury and ammoniacum. This treatment, by removing congestion and promoting the absorption of inflammatory effusion, is especially useful in chronic forms of inflammation accompanied by thickening of parts, as in the joints and testes.

CHAPTER V.

SECONDARY FORMS OF INFLAMMATION.

INFLAMMATION, if it do not terminate by resolution, passes from the forms that have just been described, into others of a secondary character. These are: 1, the Effusive; 2, the Adhesive; 3, the Suppurative; 4, the Ulcerative; and, 5, the Gangrenous Inflammations.

EFFUSIVE INFLAMMATION.

Effusions are not invariably the consequences of inflammation; serum and blood are often poured out independently of it. In a natural and healthy state, effusion or transudation of a watery fluid through the walls of the capillaries is constantly going on in all parts of the body, this *plasma* serving an important purpose in the nutritive actions of the tissues which it bathes. It is only when this is increased in quantity and altered in composition that it becomes a diseased product, constituting *œdema* in the areolar tissue, and *dropsy* in serous or synovial cavities. The fluid that is thus exuded in sufficient quantity to accumulate, is of a watery character, being neither liquor sanguinis nor serum; not containing the fibrine of the one, nor the proportion of albumen and salts of the other. Its transudation is

generally dependent upon venous congestion; thus, if the veins of the leg be compressed, œdema of the foot will occur; if those of the liver suffer pressure, ascites will result; if the renal veins be obstructed, albuminuria will ensue.

If the pressure on the vessels be still greater, the capillaries may become distended till they rupture, giving rise to effusion of blood, as in some forms of epistaxis and hæmaturia.

Now, in inflammation, an increased degree of pressure exists in the inflamed parts, the vessels being overdistended as well as dilated, and blood continuing to be pumped with augmented activity against those that are already turgid; hence there is a mechanical tendency to the occurrence of some effusions, and a disposition for the inflammation to relieve itself by the distended vessels pouring out some of their contents. But, though effusions in inflammation are partly mechanical, they are not by any means wholly so; for, in many cases, organizable matter and organisms appear which did not previously exist, and which are produced by the local actions of the part.

The proper effusions of inflammation are—1, *Blood;* 2, *Liquor Sanguinis;* 3, *Serum;* and 4, *Secretions of Tissues or Organs.* These effusions are in a great measure mechanical, depending on the dynamic state of the vessels, though doubtless in many instances modified by other causes of a vital character. Fibrine, or lymph, though usually spoken of as an inflammatory effusion, differs so remarkably in its vital characters from the rest, and is so evidently a new formation, that I shall consider it separately.

The frequency with which one or other form of effusion occurs in different tissues, or organs, varies greatly. Paget observes, "Each tissue has its proper mode and products of inflammation;" hence particular kinds of effusion are very rare in some, although of common occurrence in other parts.

1. *Effusion of blood* often occurs in small quantity, tinging the other products of inflammation. When this is the case, the coloring matter is broken down and dissolved, a condition indicative of a low state of the constitutional powers. In other cases, the hemorrhage may be abundant, the character of the blood being but little changed. This effusion is dependent upon overdistension of the vessels, with softening of the tissues, giving rise to rupture of the capillaries, without which it cannot occur, there being no such thing as *transudation* of blood in inflammation. Hemorrhage of this kind most frequently occurs from mucous surfaces, which readily bleed when inflamed. It may also happen from the rupture of new vessels in freshly-deposited lymph.

2. *Effusion of Liquor Sanguinis.*—In this case, the fluid parts of the blood transude, leaving the red corpuscles behind. It is occasionally met with in so-called serous effusions, into the tunica vaginalis for instance; so also the serum contained in the bleb of a blister is really liquor sanguinis; and Paget has found that in this there is most fibrine when there is most strength of constitution. This fluid is not uncommonly met with in the subcutaneous and submucous areolar tissues; about the glottis, and in the scrotum, for instance, giving rise to a gelatinous semi-transparent swelling of the part. In these cases, the more fluid portions are sometimes absorbed, leaving the fibrine, thus constituting the condition termed *solid œdema.* The fibrine in this effusion often does not coagulate so long as it is retained in the body; but when it is removed, solidification ensues.

3. *Serous or albuminous effusions* are very common in slight or subacute inflammations of serous and areolar tissues, giving rise to dropsies and œdema. They most frequently contain a small admixture of fibrine, approaching somewhat to the characters of the last-mentioned effusion. The quantity of the fibrine contained in them is usually a measure of the degree of the inflammation. These serous accumulations form and are absorbed with great rapidity, and their absorption is usually most rapid when the fibrination is least.

4. *Secretions of tissues and organs* undergo changes in quantity and quality, under the influence of inflammation. The quantity is at first increased; but during the active stage of the inflammation, when there is much tension, it becomes diminished, the part being almost dry; as the inflammatory action subsides, and relaxation of the vessels ensues, it again becomes increased.

The alteration in quality in secretions from *glands* is chiefly due to the admixture of morbid secretions from the mucous membrane. When a *serous membrane* is inflamed, the secretion not only accumulates in greatly increased quantity, as in

acute hydrocele, but it becomes turbid by the admixture of flakes of lymph, which are sometimes so abundant as to give it a puriform appearance. In other cases true pus is formed, as in inflammation of the anterior chamber of the eye, terminating in hypopyon. In inflammations of the *areolar tissue* the quantity of fluid is either simply increased, or it becomes fibrinous, occasioning solid œdema and induration. In inflammation of the *mucous membranes* the most important modifications of secretion occur. The first effect is to cause the transudation of a serous fluid from the mucous membrane, the secretion becoming clear, watery, and abundant. As the inflammation increases, exudation-corpuscles and large quantities of epithelial scales are thrown off, and, mixing with the mucus, make it viscid and tenacious—*ropy*, as it is termed. In the more advanced stages we find pus and exudation-corpuscles, with epithelial scales, constituting the various forms of mucopus and of true purulent secretion.

ADHESIVE INFLAMMATION.

The *adhesive* is that form of inflammation which terminates in the effusion of fibrine, lymph, or plastic matter; it may hence be termed fibrinous or plastic inflammation.

The study of the products of this form of inflammation is of great importance; not only because they form the basis of adhesive action, but because they are the media from, by, and in which all the reparative effects of inflammation take place, and the reconstruction of destroyed tissue is effected. Lymph, the material of repair employed by nature, has an independent and inherent vitality by which it is organized, irrespectively of the forces of the parts around it. It is capable of development into various tissues, and of degeneration into structures lower in the scale of organization. Many of the ulterior products of inflammation are but instances of the development or degeneration of lymph.

Although lymph is usually observed by the surgeon in a semi-solidified form, hence often termed "*coagulable lymph*," it must necessarily be separated from the vessels in a fluid state. This separation is not a mechanical act, but a vital phenomenon, analogous perhaps to the process of nutrition, by which a living organized fluid, possessing within itself the power of self-development and of organization into tissues, is separated or eliminated from the blood. It is this fibrine, lymph, or plastic matter that plays so important a part as a reparative agent in surgery; that is seen as a covering to the surface of recent wounds, glazing them in a few hours, and causing speedy union to take place between their opposed sides through its intervention.

Characters of Lymph.—The plastic (Williams) or fibrinous (Paget); and the aplastic (Williams), croupous (Rokitansky), or corpuscular (Paget), are the two varieties under which lymph is presented to the surgeon.

The *fibrinous* or *plastic* is the true healthy coagulable lymph. When first poured out it is liquid, but it speedily coagulates into a whitish, grayish, or yellowish-white, elastic semi-transparent substance, somewhat resembling the buff of coagulum. Chemically considered, it is not composed of pure fibrine, but contains an admixture of oily and saline matters, which are necessary for its development. This form of lymph is only met with in healthy and vigorous individuals, usually as the result of inflammation consecutive upon cleanly cut wounds. Under the microscope it appears filamentous in structure, being made up of delicate interlaced fibrillæ.

The *corpuscular*, *aplastic*, or *croupous* lymph differs remarkably from the variety that has just been described. In this, coagulation does not take place, but corpuscles float free in a thin clear serous liquid. This variety of lymph is met with in, and is indicative of, cachectic states of the system. The corpuscles which characterize it, commonly go by the name of *exudation-cells;* they resemble in general characters the white corpuscles of the blood, or those met with in the fluid contained in the lymphatic vessels. Gulliver states, however, that exudation-cells are larger and more irregular in size and shape than these, and usually exhibit from two to three nuclei when treated with acetic acid. They form in about four-and-twenty hours after inflammation has been set up; and may either develop, passing upwards through fibro-cells, caudate-cells, &c., into filaments; or may degenerate into pus-corpuscles, granule-cells, granular matter, and *débris*.

These two primary forms of lymph, the fibrinous and the corpuscular, are almost always found together, but existing in various proportions in the same exudation-mass; the relative quantity of the one or the other element determining, whether it shall undergo development or degeneration. Paget observes that "the larger the proportion of fibrine in any specimen of inflammatory lymph (provided it be healthy fibrine), the greater is the likelihood of its being organized into tissue;" this preponderance of fibrine being indicative of adhesive inflammation. And "the larger the proportion of corpuscles the greater the probability of suppuration or some other degenerative process;" the preponderance of corpuscles being a general feature of suppurative inflammation.

Why does lymph at different times assume different forms, fibrine preponderating in some, corpuscles in other cases? Or, in other words, why do we find a tendency to adhesive inflammation in some, to suppurative inflammation in others? This question, which has been closely investigated by Hunter, Bichat, Rokitansky, and C. J. B. Williams, has been very clearly replied to by Paget as referable to three causes: 1. The state of the blood; 2. The seat of the inflammation; 3. The degree and character of the inflammation.

1. *State of the Blood.*—Paget applied blisters to thirty different patients, and collected the sero-fibrinous fluid that accumulated in the blebs. In those who were suffering from purely local diseases, the constitution being otherwise healthy, the fibrine was firm, filamentous, and elastic; in cachectic or phthisical patients it was almost wholly corpuscular; with every intermediate variety, according to the condition of the system. As a general rule in young persons and in those of sound constitution, the fibrine is plastic; hence it is in these individuals that we may chiefly look for the union of wounds by adhesive inflammation.

2. The *seat* of inflammation modifies its product very considerably, as Bichat and Hunter long ago pointed out. Serous membranes are prone to fibrinous, the mucous to suppurative inflammation; and in areolar tissue, both fibrine and corpuscles are found. This general rule, however, is subservient to the state of the constitution, and to the influence of certain specific diseases. Thus in diphtherite and croup, lymph is poured out on the mucous membrane of the throat; whilst, in empyema, pus is formed in the cavity of the pleura.

3. The *degree* and *character* of the inflammation modify considerably the product. In slight inflammations it is almost always corpuscular; in the more acute and active, of a fibrinous character. Certain *forms* of inflammation are always attended by specific products. In pyæmia, for instance, all the products have a suppurative tendency, even when serous membranes are inflamed. In croup, on the other hand, there is a disposition to plastic effusion even on mucous surfaces.

After-Changes.—Lymph that has been poured out is susceptible of three important changes: viz., *absorption*, *development*, and *degeneration*.

When lymph undergoes *absorption*, it probably breaks up and dissolves in the fluids of the part, being carried off by the vessels; these changes we not unfrequently see taking place in an inflamed eye.

Development of Lymph.—In a healthy constitution and with a healthy local condition, lymph evinces an upward tendency in the scale of development, becoming vascular, and being converted into a fibro-cellular material. This development may be arrested by the following three conditions: viz., the state of the patient's health; the continuance of the inflammation; and a congestive state of the part itself.

If the health be impaired or broken, all development ceases: this process being essentially dependent upon constitutional force and vigor. Hence the necessity of maintaining the patient's powers, if we look for healthy and complete reparative action in a part.

The continuance of inflammation beyond a certain point in intensity prevents the development and proper organization of lymph. Thus, in a wound or an ulcer which becomes inflamed, all reparative action is at once arrested, and the lymph already deposited may retrograde or become absorbed. This property in local inflammation of imprinting a retrograde course upon lymph that has already been deposited, is taken advantage of by the surgeon, who dissolves away a hard and chronic thickening of a part by exciting inflammation in the centre of it with potassa fusa.

Local congestion of a part effectually prevents the deposit of lymph. Thus, no reparative action takes place in an ulcer seated on a congested limb.

In undergoing development, lymph always passes into the fibro-cellular state, beyond which it very frequently does not proceed. This fibro-cellular tissue, so formed, is the common connecting medium of wounds, and the tissue of which cicatrices are composed; we see it on the face of a stump, binding together all the tissues, muscles, nerves, and vessels in one common bond. It is of this fibro-cellular substance that adhesions, bands, false membranes, thickenings, and opacities are commonly formed.

Plastic matter may also be developed into bone, passing through a fibrous, or fibro-cellular transformation; and, lastly, we see it developed into epithelial scales, such as are commonly found in cutaneous cicatrices.

Vascularization of Lymph.—In lymph that undergoes development, bloodvessels are seen to make their appearance at an early period. With regard to the precise time of their formation, Dupuytren and Villermé state, from their experiments on dogs, that twenty-one days are required; and Travers, from his experiments on the frog's web, fixed the same period as that in which red blood begins to pass. In the human subject, however, the lymph on the surface of an ulcer or wound certainly appears to become vascular long before this.

How are the new vessels formed? by development in the lymph? or by extension from surrounding parts? Hunter and Rokitansky incline to the former opinion. Travers and Quekett, who investigated the matter fully, believed that the vessels are always projected into the lymph from neighboring parts; and Paget agrees with these observers. Travers states distinctly, as the result of his observations, which are borne out by the results of the experiments of the late Dr. Tod, that "there is no such thing as independent vascularization; the whole business of organization is of and from the margin of the wound."

According to Travers, the following are the periods of development of vessels in a frog's web which has been wounded.

Up to the fourteenth day there is stasis of blood in the vessels adjoining the wound. From the fourteenth to the twenty-first day channels are opened in the plastic matter, at first colorless, then admitting single blood-corpuscles; from the twenty-first to the twenty-eighth day, the circulation is more active, the vessels enlarging and anastomosing; in the fifth week, transparent capillaries pass across from the colored arteries to the veins; and in the sixth week there is the formation of new vessels in loops, half-circles, &c.

The steps by which this interesting process is accomplished, are the following: At first, small lateral dilatations or pouches appear at some points on the walls of the nearest old vessels; these grow out into the plastic mass, bend towards each other, coalesce, and form loops or forks. These loops give rise to secondary vascular outgrowths; and thus the vascularization of the lymph is completed.

Travers states that these vessels are visible, like fine striæ, before the circulation can be detected in them. A single blood-corpuscle first enters; this is followed by others, which for some time have a see-saw or oscillatory motion, progressing gradually towards the nearest vessel; by the entrance of the blood into which the circulation is completed, and becomes continuous and equable.

Degeneration of Lymph.—This has been especially studied by Paget. He observes that it may wither and harden, forming dry horny masses or vegetations; that it may undergo fatty degeneration, and become converted into granular matter. These last two forms of degeneration are frequently met with in the coats of diseased arteries. Besides these changes, it may calcify, being converted into an inorganic earthy material; it may undergo pigmentary changes; and, lastly, it is very frequently converted into pus.

SUPPURATIVE INFLAMMATION.

The *suppurative* is that form of inflammation which gives rise to the production of pus; and pus never occurs except as the result of this form of inflammatory action.

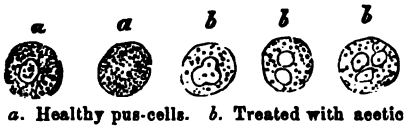
Characters of Pus.—Pus presents considerable variety in its general character, according to the nature of the constitution of the patient, or the condition of the part in which it is formed.

When formed in a person of healthy constitution, as the result of sthenic inflammation, it is an opaque, creamy fluid, thick, smooth, and slightly glutinous to the touch; of a yellowish-white color, with a greenish tinge, having a faint odor and an alkaline reaction. Chemically, it is composed of water containing albumen, fibrine, saline, and fatty matters in solution and admixture, and usually gives off a small quantity of ammonia. Pus presenting these characters is termed *healthy* or *laudable.*

When admixed and tinged with blood, it is said to be *sanious;* when thin, watery, and acrid, *ichorous;* when containing cheesy-looking flakes, it is termed *curdy;* and when diluted with mucus or serum, it is frequently called *muco-pus*, or *sero-pus.* Besides these, pus presents many other varieties. Thus, for instance, when formed from bone, or in the neighborhood of the alimentary canal, it has a peculiar fetid odor. Its chemical composition may likewise vary under different circumstances; thus, ordinary pus formed in the soft parts contains merely a trace of phosphate of lime, whereas that which is formed in connection with diseased bone has been found by B. Cooper to contain 2½ per cent. of this salt. Sometimes animalcules are found in pus; vibriones are met with in some kinds of pus from the genital organs. Pus presents other peculiarities, which are only cognizable by their effects on the system: thus, the pus from specific sores possesses contagious properties, though in chemical, microscopical, and physical constitution, it does not differ from other forms of that fluid.

Microscopic Characters.—On examining pus under the microscope, it is found to consist of corpuscles floating in a homogeneous fluid, the "liquor puris." These corpuscles appear to be modifications of the exudation-cell; being composed of a semi-transparent cell-wall, containing two or three nuclei, which are rendered very apparent by acetic acid (Fig. 54). Besides these, a large quantity of granular matter, of particles of fibrine, and of disintegrated exudation-cells, are usually found admixed with it. The greater the quantity of corpuscles, the richer and more creamy is the pus.

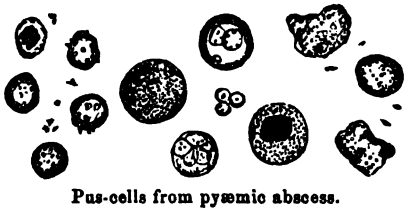
Fig. 54.



a. Healthy pus-cells. *b.* Treated with acetic acid. Magnified 800 diameters.

In many cases, however, the microscopical characters of pus differ from those that have just been given. Thus, in the thin, greasy, yellowish-looking pus, somewhat resembling melted butter, which we find in the joints in pyæmia, the pus-corpuscles are irregular in outline, and not so distinctly nucleated (Fig. 55); and

Fig. 55.



Pus-cells from pyæmic abscess.

Fig. 56.

Pus-cells from scrofulous abscess.

in some forms of chronic abscess, when the pus is thin and curdy, the pus-corpuscles present a somewhat similar appearance, undergoing fatty degeneration (Fig. 56).

Pyogenesis or the **Formation of Pus,** is an interesting study. The older surgeons believed that this fluid was formed by the breaking up or disintegration of the solid tissues, or that it was the result of their liquefaction or saponification by the acid products of inflammation. Quesnay and Haller exposed the fallacy of these opinions; and modern pathologists look upon pus as a direct product of inflammation.

Pus-cells have been shown by recent observers to be modified or degenerated exudation-corpuscles, and the fluid in which they float to be of a serous character. In many cases the transition from lymph to pus-cells can be seen to take place;

thus Paget has observed that the fluid contents of the vesicles of herpes, which are corpuscular exudation-matters, become purulent in twenty-four hours. So, again, every surgeon must have repeatedly observed that, in cutting into some forms of abscess in their early stages, a sero-plastic fluid escapes, which, in the course of a day or two, becomes purulent. So likewise, in amputating in the vicinity of an inflamed part, the tissues appear to be infiltrated with gelatinous exudation-matter, which, in the course of a few hours, becomes converted into pus.

Pus may be formed on the free surface, or in the substance of parts. The first constitutes a *purulent secretion;* the second, an *abscess.*

When formed *on a free surface*, whether this be serous or mucous, the pus-cells appear to be modified exudation-corpuscles floating in the watery effusions of the inflamed part.

When pus forms in the substance of a tissue or organ, constituting an *abscess*, there is in the first place a high degree of inflammatory action. Sero-plastic exudation is thrown out, infiltrating the tissues; and in the centre of this, where the inflammation attains its greatest intensity, the exudation-cells become transformed into pus-corpuscles. A drop of pus is thus formed in the inside of the exudation-matter already effused, or at the moment of its evolution, as the result of changes imprinted on it by contact with the inflamed parts. Around the pus thus formed, the lymph deposited in the substance of the tissues, and filling up their interstices, forms a consolidated mass, which plays an important part in limiting the further extension of the suppuration. As the suppurative action advances, the corpuscles composing the innermost layers of this plastic mass are gradually transformed into pus-cells; the blastema losing its plasticity, and degenerating into liquor puris.

The purulent accumulation thus formed, constituting an abscess, is always retained, in healthy states of the system, by a boundary of consolidated lymph, which extends itself by fresh deposits on its outside, and by the liquefaction and metamorphosis of its interior, as the central formation of pus increases. This boundary of lymph has been termed the *pyogenic membrane*, and was supposed by Delpech to be the secreting organ of pus. This, however, it is not; and that it is not necessary for the secretion of pus, is shown by the facts, that it is not found in the early stages of suppuration; that on free surfaces suppuration occurs without it; and that it is absent in certain kinds of abscesses—the diffused and the metastatic. A better term for it would be the "limiting fibrine," as it limits or bounds the spread of suppurative action. Its absence is usually indicative of a want of power in the system; the suppuration then becoming diffused, extending itself indefinitely through the areolar tissue.

Diagnosis.—The diagnosis of pus is usually easy, but some fluids resemble pus so closely to the naked eye, that the microscope is necessary to establish their characters. From *healthy mucus* there is no difficulty in distinguishing pus; but when mucus has been thickened and rendered opaque by inflammation, and is mixed with exudation-cells, it is impossible, and can never be necessary, to distinguish it from pus. *Turbid serum*, containing broken-down and granular fibrine, frequently met with in serous sacs, closely resembles pus; here the diagnosis may be effected by the absence of cells. *Softened fibrine*, as in clots and inflamed vessels, often closely resembles pus to the naked eye, but the microscope reveals the true nature of the fluid by the absence of exudation-cells. *Atheroma* may be distinguished from pus by the presence of cholesterine-granules and fat, and by the non-existence of the characteristic pus-corpuscle. In *tubercle* and *cancer* the absence of the true pus-cell, and the presence of appearances characteristic of these morbid products, establish the diagnosis. When it is admixed with *blood*, the detection of pus is often very difficult, and, indeed, cannot in many cases be satisfactorily accomplished; the white corpuscles have sometimes been mistaken for its cells, to which they have a great resemblance. When pus is diffused in *milk*, as in some forms of lacteal abscess, the corpuscles of this fluid will be seen to be smaller and clearer, with a more defined outline than those of pus.

The *duration* of suppuration varies greatly. Inflammation very commonly terminates in the formation of pus, in the course of about three days; at other times a much longer period than this is required, the inflammatory action being of a passive and languid character. When once suppuration has been set up, it may continue for an indefinite time; pus becoming, as it were, the established secretion

of the part. It is not uncommon to find purulent discharges from mucous membranes continuing for years.

The *characters* of suppurative inflammation vary according as it is healthy, unhealthy, or specific.

Symptoms of Suppuration.—These are local and constitutional.

The *local symptoms* differ as the suppuration occurs on a mucous surface, or in an internal cavity or organ.

When an inflamed mucous surface is about to suppurate, the membrane presents the ordinary characters of active inflammation, being swollen, red, and often painful; to these a discharge is speedily superadded.

When suppuration is about to take place in the substance of tissues or organs, the local symptoms of inflammation undergo certain modifications indicative of the supervention of this action. The pain becomes throbbing; the part swells and becomes tense, but after a time softens; and fluctuation or undulation may be detected in it. The skin becomes glazed, red, shining, and œdematous. In other cases, again, suppuration occurs without any evident sign of local inflammation, the presence of the pus revealing itself by swelling and fluctuation only.

Constitutional Symptoms.—On the supervention of extensive suppuration, the ordinary symptoms of inflammation subside, and are usually interrupted by the occurrence of chills, alternation of heat and cold; or, if the formation of pus be extensive, by severe and long-continued rigors. The fever often assumes a somewhat intermittent character, and its intensity lessens, the pulse becoming soft, though continuing quick. If pus be formed in sufficient quantity for its discharge to act as a severe drain on the constitution, other symptoms speedily set in, dependent on the loss that is going on. The patient becomes weak, his nutrition is impaired, and *hectic* is established.

Hectic does not come on unless there be a discharge of pus from the system. No hectic occurs so long as an abscess, however large, continues unopened; but it supervenes with great rapidity when once its contents are discharged. I have known a large abscess to exist unopened for two years, without any constitutional disturbance; but, so soon as it was opened, well-marked hectic set in, which speedily carried off the patient.

Hectic is essentially a fever of debility, conjoined with irritation. Emaciation and general loss of power invariably accompany it. The pulse, which is quick, small, and compressible, rises from ten to twenty beats above its normal standard; the tongue becomes red at the edges and tip; the cheeks are often flushed, and the eyes glistening, with dilated pupils; all these symptoms have a tendency to exacerbations after meals and towards evening. There is also increased action, either of the skin, bowels, or kidneys. Thus, profuse sweating, copious purging, and abundant red deposits in the urine take place; these discharges often alternate with one another, melting the patient away, and hence are termed *colliquative*. The debility gradually increasing, the patient rapidly wastes, and at last dies from sheer exhaustion, the conjoined result of fever, malnutrition, and wasting discharges.

In some cases of extensive suppuration, especially in children, hectic does not occur, but marasmus or atrophy takes place instead, the child wasting away without fever, and being carried off at last by exhaustion or some intercurrent disease.

Circumstances influencing the Tendency to Suppuration.—Inflammation tends to suppuration under the influence of conditions very similar to those that give rise to the formation of corpuscular rather than fibrinous lymph. Indeed it must be borne in mind that there are no very definite limits between these two products of inflammation—exudation corpuscles and pus-cells. We see that, in a sore, the same action will generate cells which very closely resemble one another. Some of these are exudation, becoming organized; others again are pus-corpuscles, and become eliminated.

1. The *state of the patient's health* exercises a great influence on the probable tendency to suppuration. The sounder the constitution, the less is the chance of inflammation running into the suppurative form. And indeed we may often, in surgical practice, look upon the suppurative tendency of wounds as a measure of the state of the patient's health. Thus, in scrofulous constitutions, the inflammation that is excited by a trivial injury, as the sprain of a joint for instance, is very apt to run on to suppuration. So again, in certain cachectic states of the system, slight wounds suppurate, or fester, as it is termed.

2. The *specific character of the inflammation* often determines the supervention of suppuration: some diseases, such as gonorrhœa and purulent ophthalmia, consisting essentially in the secretion of pus by a free surface.

3. The *seat of inflammation* also exercises considerable influence. Thus, mucous membranes, when inflamed, almost invariably suppurate, the transition from their normal secretion to pus being very readily effected. Serous membranes do so but rarely: the puriform fluid secreted by them when inflamed being in most cases nothing but turbid serum.

4. The *intensity of the inflammation* increases the liability to the formation of pus; hence pus usually forms in the centre of inflamed parts. When the inflammation is of an active sthenic character in a healthy constitution, it requires considerable intensity to give rise to suppuration. It is only where the system is strongly predisposed by struma or cachexy, that very slight inflammations terminate in this way. The degree of inflammation required for the formation of pus varies greatly, but it is always greater than that necessary for plastic exudation.

5. The *local condition of the part* influences the probability of suppuration. Thus a subcutaneous wound, as in tenotomy, does not suppurate; but if it be opened, and its interior exposed to the air, then degeneration of exudation cells, which constitutes their conversion into pus, takes place. For the same reason all ulcers suppurate. The lodgment of foreign bodies, as of urine, a piece of bone, or a bullet, by exciting intense and continuous inflammation, almost inevitably leads to suppuration, which is indeed the means adopted by nature for their removal from the system.

Treatment.—The treatment of this form of inflammation is divisible into local and constitutional.

Local Treatment.—This presents three indications:—

First, to remove the cause; as by extracting a piece of dead bone from the bottom of a sore.

Secondly, to lessen inflammatory action by appropriate means; thus either removing the inflammation entirely, or confining it within those limits that are compatible with the effusion of plastic matter.

Thirdly, to facilitate the escape of the pus, if it be lodged in tissues or deep cavities; and to moderate or arrest the amount of its discharge, when it is poured out from a free surface, by the use of astringents of various kinds, or by the proper employment of pressure.

Constitutional Treatment.—With the view of preventing the occurrence of suppuration, we must be careful to maintain the powers of the system, and not to reduce the patient too much, even if the inflammation be of a sthenic character at the outset. Suppuration is a condition of debility, and is especially predisposed to by any previously existing enfeebled state of the system, or by malnutrition. Another reason for the avoidance of the early employment of debilitating means is, that, if suppuration once be established, the drain on the system may eventually be so considerable as to require all the patient's powers to enable him to bear up against it. Hence they should be husbanded from the first. After the discharge has taken place, nourishing, tonic, and even stimulating treatment will be required in proportion to the amount of debility that is induced. Amongst the most useful medicinal agents are mineral and vegetable tonics, the mineral acids, and cod-liver oil. Attention to hygienic conditions, with change of air and residence at the sea-side, is also most valuable. When hectic comes on, the same general tonic plan must be adopted, whilst we have recourse to means adapted to meet the special symptoms. Thus, acids are required to check the sweating, astringents to arrest the diarrhœa, and as much mild nourishment as the patient will bear, to support the strength.

ULCERATIVE INFLAMMATION.

The *ulcerative* is that form of inflammation which terminates in the formation of an ulcer. An ulcer may be defined to be a solution of continuity, with loss of substance; a cavity or hole slowly produced by some action going on in the part itself, or suddenly by chemical agents, destroying the textures, and attended by the secretion of pus. Ulceration is that process by which nature separates parts that have, from whatever cause, lost their vitality, and is diametrically opposed to adhesive inflammation, being attended by an absorbing, and not a depositive action. There

are two distinct stages described as constituting the process of ulceration, attended by the most opposite phenomena; viz., 1, the period of *Destruction;* 2, the period of *Reparation.* To the first only can the term be properly applied, the stage of repair being one of deposition. The process of ulceration must always be confined to the surface, and cannot occur within the texture or substance of parts. It is most common on the cutaneous and mucous surfaces, but likewise occurs on the lining membrane of bloodvessels and on serous membranes.

Nature of the Ulcerative Process.—In what does ulceration essentially consist? Is it simply an arrest of nutrition—a cessation of the deposition of new materials, whilst the old ones are removed—a passive state in which absorption is normal, and deposition imperfect? Or, is it an active condition of the absorbents, deposition being normal, but absorption being carried on with too great vigor? Or, lastly, is it a process of disintegration, of elimination, of ejectment of spoiled and dead matters; a detachment of the disorganized soft tissues, as we see occurring in sloughing ulcers or in the removal of carious bone, in its disintegration by pus? Probably all these conditions enter into ulcerative action, but more especially the latter. It might be supposed that the precise share that each takes could be determined by a reference to the agency by which ulceration is effected, whether by the absorbents or by the veins; but this cannot be ascertained at present; and that ulceration occurs independently of either set of vessels is evident, from the fact that it is met with in parts, as the cornea and cartilage, where neither exist. Doubtless, in many cases ulceration consists essentially in the disintegration, softening, breaking down, or, as it has been termed, the "molecular death" of the tissues, and the detachment of these spoilt matters, by a peculiar action of the subjacent living structures.

There are certainly two conditions in which ulceration may occur: with and without inflammation. Inflammation may give rise to ulceration in two ways: 1, by directly softening and disorganizing the structures; and thus occasioning the more rapid or acute forms of ulceration, that are accompanied with much sloughing and signs of active inflammation, great pain, heat, and redness; 2, by chronically modifying nutrition, inducing induration and plastic infiltrations, which, under the continuance of the inflammatory process, soften and break down, becoming converted into ill-organized pus, mixed with the *débris* of the part.

Tissues that have been congested for a long time are apt to inflame under the influence of some trivial exciting cause, and rapidly to run into ulceration. This usually commences in the centre of the part, where the nutrient action is lowest; here a small sore forms, which exudes thin unhealthy pus, and rapidly extends. So long as the sore is inflamed, it continues to spread, and reparation cannot go on in it. It would appear as if a moderate degree of inflammation were too intense for the vitality of chronically congested tissues, or of those in which lowly organized fibrine has been effused. The more the vitality of a tissue is reduced, the less appears to be the degree of inflammation that is required to produce disintegration and ulceration of it. Indeed, if the vitality of a part be sufficiently lowered, it may fall into a state of ulceration without the occurrence of inflammation, or with so slight a degree as scarcely to be appreciable; the ulcerative action appearing to arise from disintegration dependent upon the want of nutrition. Thus, for instance, in scrofula and in other diseases, as scurvy or syphilis, where there is an imperfect nutritive force, a tendency to softening and breaking down of structure, and consequent ulceration, occurs; and this tendency is much increased by the occurrence of congestive or subacute inflammation in the part.

Ulceration is so intimately allied with sloughing and gangrene, that it is very difficult to separate its causes from those of these other conditions.

Causes.—The *predisposing causes* of ulceration are chiefly found in those conditions that interfere in any way with the nutrition of a part. A feeble circulation, such as often exists in the lower limbs, in the alæ of the nose, and in newly-formed or recently cicatrized parts, tends to the formation of ulcers. As age advances, nutrition becoming impaired and the circulation less active, slight causes suffice to disintegrate the structure of a part; and malnutrition, or loss of innervation from any cause, by lessening the vitality and resisting power of tissues, has a tendency to give rise to ulceration. Hence we so commonly see ulcers of the legs in elderly people, more particularly amongst the poorer classes, arise from slight irritation or pressure. In the dogs that Magendie starved by feeding them on sugar, gum, or oil

and distilled water, ulceration of the cornea occurred. This must have been the result of simple malnutrition, rather than of inflammation.

Ulceration may be directly *excited* by the intensity of the inflammation at once destroying or disintegrating a part; by a severe mechanical injury, long-continued pressure, or the application of a chemical irritant, producing direct breach of surface; and, lastly, by the influence of certain specific diseases, which are accompanied by want of nutrition, as scurvy and some scrofulous affections, the peculiar character of which consists in the ready production of ulcerative action.

Forms of Commencement.—Ulceration may commence in several distinct ways on the cutaneous and the mucous surfaces.

1. There may be such a degree of acute local inflammation as rapidly gives rise to "molecular death" of the part. If the action be not a very acute one, and the destruction of the tissues not very rapid or extensive, the disorganized matters become mixed with pus, and are discharged in the form of a dirty, brownish, puriform fluid. If the action be more violent than this, complete disintegration does not take place in the affected part, but shreds of the spoilt tissues continue attached for some time to the ulcerated surface, giving it a very ragged appearance. If the inflammation be of a more intense character, layers of disorganized tissue, constituting "sloughs," are formed, and remain in contact with the ulcerated surface, often covering it in completely, and invading with considerable rapidity the neighboring healthy structures. Thus some of the forms of phagedænic or sloughing ulcer are constituted.

2. Chronic inflammation may give rise to ulceration, by so interfering with the nutritive actions that the balance of absorption and deposition is disturbed in favor of the former. The ulcerative effects of chronic inflammation are especially marked in parts that have been chronically congested; the congestion having given rise to such softening and loosening of tissue as materially facilitates ulcerative action.

3. Ulceration sometimes commences in the crypts or follicles which open on the mucous surface, some modification of structure taking place in their epithelial linings, which leads to the formation of circular depressed ulcers, such as may often be observed about the tonsils.

4. A vesicle or pustule forming on the cutaneous surface, and shedding its contents, very commonly gives rise to an ulcer, as in rupia and pemphigus.

5. Suppurative inflammation not unfrequently occurs in the subcutaneous or submucous areolar tissues, and, by undermining and consequently destroying the vascularity of the skin and mucous membrane, and thus arresting its nutrition, gives rise to ulcer.

6. In some specific cases, we find that ulceration is preceded by the formation of a morbid growth, tubercle, or tumor, in which inflammation and disintegration of tissue, and consequent lesion of substance, occur.

Stages.—In whatever way ulceration commences, it presents three distinct stages: viz., 1. *Extension* or *Slough;* 2. *Arrest* with *Deposit of Plastic Matter;* and 3. *Repair by Granulation* and *Cicatrization.*

1. When the ulcer is *spreading*, there is always a circle of inflammation around it, as evinced by redness, heat, and a burning, throbbing pain; its edges are jagged, eroded, or sharp cut; its surface, which is more or less of a circular or oval shape, spreading nearly equally from one starting-point, and being covered with a grayish or yellowish, soft, adherent slough. In ordinary cases this is thin and shreddy, but in some forms of ulceration it is soft, pultaceous, and elevated above the surrounding parts. There is either no discharge at all, or else a bloody, ill-conditioned fluid, hardly deserving the name of pus, drains from the surface.

2. In the next stage of ulceration, that of *arrest*, the symptoms of inflammation diminish, and a layer of plastic matter is deposited in the tissues forming the base and sides of the ulcer. This not only serves to arrest or limit the further process of ulcerative action, but becomes the medium of its ultimate repair. The surface begins to clean, the gray adherent slough separating in fragments and dissolving away in the discharge, which gradually loses its sanious tinge, and assumes more the characters of healthy pus, though still very scanty in quantity. The surface continues flattened, its sensibility diminishes, and the edges are often elevated and indurated. In this stationary condition an ulcer may remain for many months; and it is that in which we commonly find chronic sores.

3. The last stage, that of *repair*, is characterized by the formation of granulations, which may be looked upon as the turning point in ulceration. Until granulations are formed, ulceration is a wasting process, or at most stationary; so soon as they are formed, repair commences. Instead of a tendency to increase, to erosion, and to concavity, we now find a disposition to contraction, to deposition, and to convexity of the surface, which assumes a bright red hue, of a vermilion or scarlet tinge, appearing to be studded with minute papillæ: the edges become rounded and smoothed down towards the surface, losing their sharp cut appearance; and the discharge assumes the characters of healthy pus.

Repair of Ulcers.—We now proceed to study the changes that occur in an ulcer during the stage of repair—the processes of *granulation* and of *cicatrization*.

Granulation.—So soon as inflammation and extension of ulceration are checked, the surface of the ulcer, as has already been stated, becomes covered by a layer of plastic matter. This plastic layer, separating the ulcer from surrounding and adjacent tissues, forms a basis from which the granulations, the organs of repair, spring up. Before this plastic basis can be deposited, it is necessary that the inflammation be reduced within those limits that are compatible with plastic effusion. So long as inflammatory action exceeds this limit around the edge or at the base of the ulcer, no lymph is effused. But as soon as this undue action is checked, lymph is thrown out, which becomes vascular by vessels shooting into it from below; and assumes a granular form from its deposition in papillæ, or granulations, which are consequently composed of exudative matter that has become vascularized in the way that has already been described. In the great majority of cases, granulations are formed only on surfaces exposed to the air and secreting pus; but they may be formed without exposure to the air or the formation of pus, as Hunter and Paget have shown to occur in some cases of fracture, the ends of the bones being covered by a distinct layer of florid granulations. That these granulations are in reality composed of lymph that has become vascular, is evident from the interesting fact observed by Hunter, and which every surgeon must have had repeated occasion to verify, both in wounds and in compound fractures—that a portion of bluish-white semitransparent lymph effused on the surface of the sore or denuded bone is seen to become vascularized, and to be converted into true granulations, in from twenty-four to forty-eight hours.

The microscope shows that granulations are composed of cells heaped up without much, if any, apparent order, and connected by but little intermediate substance. When single, they are colorless; when in clusters, they become ruddy. It is interesting to observe how these cells undergo different changes in different parts of the same ulcer. Those situated at the base nearest the attached surface of the granulation, constituting its deeper layers, undergo development into filaments and fibro-cellular tissue; those on the surface are either thrown off in a rudimentary form, or degenerate into pus-cells; whilst those at the edges become converted into epithelial scales. Thus we see the same action giving rise to exudation-corpuscles, to pus, to epithelium, and to fibro-cellular tissue.

The *development of vessels* in granulations—a most wonderful and beautiful process by which thousands of vessels may form in a day on a healthy granulating surface—is identical with their general development in lymph, which has already been described (page 109): a series of loops and arches being formed as outgrowths from neighboring vessels.

The *sensibility* of granulations varies considerably, being often greatest in those which spring from tissues that are naturally the least sensitive, as bone for instance. No nerve has been traced in granulations; hence their apparent sensibility would appear to depend upon that of the subjacent inflamed tissues.

The *characters* of granulations afford important indications to the surgeon as to the condition of the surface from which they spring, and the state of the patient's general health. Granulations indicative of a healthy local and constitutional condition are small, florid, pointed, closely set, and bathed with healthy pus; the use of which appears to be to cover and protect the tender surface with a soft lubricant coating, into which the granulations may sprout without being dried by the air, or readily damaged in any other way.

In a weak state of the sore, or of the constitution, the secretion of pus diminishes, and it loses its healthy character; the granulations become large, pale, and flabby, appearing to be œdematous from infiltration of serum, and assuming a glassy or

semitransparent look, with a purplish hue. Occasionally hemorrhage takes place into them, and they become broken down and sloughy. If, whilst a sore is healthily granulating, morbid action be set up in it, or in the economy—as by the supervention of erysipelas or fever—the granulations and pus-cells degenerate at once; the granulations becoming rapidly absorbed, the surface of the sore assuming a grayish, sloughy look, and the formation of pus being arrested.

The *healing process*, or *cicatrization*, is that by which the ulcer closes and becomes covered by an integumental investment. Two distinct processes, though carried on simultaneously, are necessary for the accomplishment of this. These consist in the granulations assuming a healthy character, and covering themselves with new cuticle; and in the contraction of the surface of the sore.

The first change that takes place in an ulcer that is about to undergo the healing process, is that the granulations become florid, and are bathed with healthy pus; the edges and surface of the sore then assume the same level—the granulations rising, and the edges subsiding. So long as there is any inequality in this respect, the process of cicatrization cannot go on. The granulations nearest the edges become smooth, cease to pour out pus, and become glazed over with a thin, whitish-blue pellicle—which is the first appearance of new skin—composed of granulation-cells developing into epithelium. As cicatrization advances, the part of the sore immediately inside this bluish-white line will be seen to be occupied by a red zone, which, in the course of four-and-twenty hours, becomes, in its turn, new epithelium, and appears to be the link between granulation and true cuticle.

At the same time that these changes are going on, contraction of the sore takes place. This would appear to be entirely a mechanical process, and not a vital action; it is owing to the conversion of the exudation-cells of the granulations into the filaments of cicatricial tissue, which, being more closely packed and becoming drier, occupy less space (Paget). This contraction commences as soon as the sore presents a tendency to cicatrize, and continues for a considerable time after this is completed.

Cicatrization advances with greatest rapidity around the edges of the sore, the centre taking the longest time to heal, in consequence of the activity of the process appearing to diminish the farther the new skin extends from the old tissues. Indeed, if the ulcer be large, there may not be sufficient force for the cicatrization of its centre. A sore of a circular shape usually takes a longer time to heal than an oval elongated one; the reason appearing to be that the new skin is formed at the edge only, and never in the centre of an ulcer; unless it happen that islands of old skin are left there undestroyed, which serve as centres of cicatrization. It would appear to be necessary for the healing process, that granulations have some of the old textures to be modelled upon, the characters of which they then, and only then, appear to assume; receiving, from the plastic force of the old tissues on which they are deposited, an impulse which causes their development into analogous structure.

The *changes* taking place in a cicatrix do not cease with its formation. Two processes continue for a very considerable length of time afterwards: viz., the gradual contraction and the development of the cicatricial tissue.

We have seen that granulations tend to contract during the healing of an ulcer, and that the diminution in surface thus produced facilitates greatly its cicatrization. Hence a scar is never so large as the original sore. This contraction continues, however, and does not attain its maximum until long after the completion of cicatrization, often occasioning great puckering or deformity. The degree of contraction depends partly on the seat of the scar, but principally on the agent that produces the ulcer; if the scar be seated on a part where the skin is very tense, the contraction will be slight; if the skin be naturally loose it will be considerable. The contraction that takes place in scars which result from burns is greater than in those which occur from any other cause, often producing serious deformity and great distress to the patient. These results do not supervene in their fullest extent until after a lapse of some weeks or months from the infliction of the injury. This contraction would appear in some cases to be due, not only to the consolidation of the texture of the scar, but to the development in it of yellow elastic tissue.

Two great changes are wrought by time in the texture of a cicatrix. In the first place, its tissue assimilates more and more to the normal structure of the part; and secondly, its deep attachments become more movable. When first a scar is formed, it is thin, reddish, or bluish and shining, being composed of imperfectly

developed filamentous tissues, covered by a thin epithelial layer. As it becomes older, it assumes a dead-white color, and becomes depressed, and gradually, but slowly, many years being required for the change, it "wears out;" that is to say, its structure more closely resembles that of the texture of the part on which it is seated. It never, however, becomes developed into true skin, as neither hair nor sebaceous or sudoriferous glands form in it.

In *structure*, cicatrices are composed of a fibro-cellular tissue, rather sparingly supplied with bloodvessels, and covered by a thin epithelial covering, usually smooth and glistening, but sometimes nodulated and rugose.

The *sensibility* of the cicatrix itself is lower than that of the skin generally, but it will usually be found that the edges of the integument, when in contact with the cicatrix, are more highly sensitive than are the integuments on other parts of the body. When tough and irregular cicatricial bands, or "*bridles*," stretch across a part, it will usually be found that they are devoid of sensibility.

Coincidently with these changes, the scar loosens its deep attachments, so that it can be moved more freely upon subjacent parts. It is a long time before the scar attains the vitality of the older structures, if ever it do so completely; and the larger it is, the less its power will usually be. Under the influence of scurvy or syphilis, an old scar is apt to open up again; so also, if a fresh ulcer is formed on the old cicatrix, it will take a longer time to heal than the original one.

Diagnosis.—This is readily made when ulcers are seated on the skin, where no art is required to recognize a sore. On the mucous surfaces, however, it is not always easy to do so; enlarged follicles and crypts, or aphthæ, being constantly confounded with ulcers. The difficulty here proceeds from the circumstance that muco-pus may be poured out from a simply inflamed surface, or from one in which the abraded epithelium and open cryps are mistaken for ulcers.

Treatment.—In the *local treatment* of ulcers, the following points should be particularly attended to. 1. Inflammation must be subdued; until this be done, no proper reparative action can go on. This is accomplished by the ordinary local antiphlogistic treatment. 2. Position and rest are essential, in order that congestion or determination of blood may not take place. 3. Proper local applications adapted to the nature of the case, of an emollient, sedative, astringent, or stimulating character, must be employed frequently, conjoined with pressure upon, or support to, the weakened vessels of the part.

The *constitutioual treatment* must be carefully attended to. Unless this be done, the best regulated local plan may be employed in vain. Attention to the digestive organs, and improvement of the constitution, if it be strumous or syphilitic, will do more in these cases than any other means can accomplish.

GANGRENOUS INFLAMMATION.

Causes.—Gangrene may result either from the *intensity* or from the *specific character* of an inflammation.

The *intensity* of the inflammation may be so great as to kill the part directly, however healthy its texture or sound the constitution of the patient may be. More commonly, however, it is not so much the actual as the relative intensity of the inflammation that destroys the part: there being some debility, local or constitutional, by which its resisting or preservative power is lessened. It is this occurrence of inflammation in a part or system in which the vital force is defective that is especially apt to result in gangrene; and it is remarkable to observe what slight injuries will induce gangrenous inflammation under these circumstances, especially in residents in towns and in those who are debilitated. The greater the general and local debility, the greater will be the liability to gangrene. The nature of the tissue exercises, however, considerable influence; thus, with a moderate amount of inflammation, some tissues, when inflamed, very readily run into gangrene, the areolar membrane especially being apt to do so; whilst others, as the proper tissue of glands and organs, are seldom so affected.

The *specific character* of the inflammation influences greatly the disposition to gangrene; some forms, as the carbuncular, invariably resulting in the loss of vitality of the part. In some states of the constitution, the blood appearing to be diseased, there is a great liability to gangrene.

Symptoms.—When a part has been violently inflamed in consequence of injury,

or some such cause, we look upon gangrene as impending if we find that the redness becomes of a dusky or purplish hue; that bullæ filled with dark fluid rise upon the surface; that the swelling, at first hard, tense, and brawny, becomes of a pulpy or doughy character; that the pain is of a dull, heavy, or burning kind; and that the temperature of the part, at first greatly increased, gradually sinks. We know that gangrene has taken place when there is a total loss of the sensibility of the part, even to pricking or pinching; that the motion of the part itself ceases; that its color changes to a peculiar mottled, purplish-red, or greenish-black hue, unlike anything else in the body; that the temperature falls to a level with that of surrounding parts; or that the surface affected, if extensive, may even feel colder, owing to evaporation from it. There is likewise an odor evolved, differing from that of ordinary decomposition, and evidently depending upon gaseous exhalations from the part that has lost its vitality.

These signs constitute *moist* or *acute* gangrene, occurring as the result of inflammation. Death and putrefaction are simultaneous in this case; the putrefaction being evidently the result of changes effected in the tissue by the inflammatory act, and not by *post-mortem* chemical decomposition, the part being decomposed at the same time that it is killed. The extent of tissue affected may vary from a mere spot to the implication of the greater portion of a limb; and the gangrene appears to be finally arrested by the inflammation expending its force as it radiates from the centre, and reaching a part where there is sufficient vitality for adhesive inflammation to be set up.

The *constitutional symptoms*, always of a low type, vary according to circumstances. If the blood be healthy, and the constitution sound, the gangrene occurring as the consequence of severe injury, the symptoms will present the ordinary character of inflammatory fever, though even in these cases there is a great tendency to asthenia. If the constitution be broken, or the blood in a diseased state, the constitutional symptoms will rapidly run into the irritative form.

Arrest of Gangrene.—The *progress* of gangrenous inflammation would be indefinite, were it not arrested by the adhesive process which limits it, just as it bounds the suppurative inflammation. So soon as the gangrene reaches a part the vitality of which is too active to be destroyed by the inflammatory action, and where inflammation consequently takes on that form which it always does in healthy tissues —the adhesive; or, if the inflammation, gradually lessening in severity as it extends from its gangrenous centre, subsides to that degree which is compatible with the formation of lymph, the *line of demarcation*, as it is termed, is formed. This line is a kind of barrier or septum of plastic matter, poured out into the interstices of the healthy tissues at their extreme limits next the gangrene; the line, indeed, along which the dead and living parts touch. It extends along the whole depth of the gangrene, completely surrounding it on all its attached sides. The inflammation does not cease abruptly in this line, but fades away in the healthy parts beyond it.

But not only does this plastic *line of demarcation* form in those cases in which the gangrene is consecutive upon intense inflammation; it is developed equally in those cases where, as from severe injury or disease of the arteries, the gangrene is the primary and immediate affection, and the inflammation the secondary and consequent condition. In these cases, it would appear to be formed exactly by the same process, and by the same mechanism, as that by which lymph is effused around any foreign body or fluid accumulation that has lost its vitality. Just in the same way as lymph forms the boundary wall to extravasations of blood, or to accumulations of pus, so it forms a barrier, deposited in the living tissues, to separate them from the dead structures beyond, which by their very loss of vitality have become foreign to the healthy structures in their neighborhood.

So soon as the gangrene is arrested, nature endeavors to throw off the spoilt parts, by a series of actions which take place in the living structures immediately contiguous to them, and not by a mere process of disintegration or of falling to pieces of the gangrened parts. This process is effected by ulceration, extending through the line of demarcation, and loosening the slough by the absorption of that layer of living tissue which lies next to it. This line of ulceration is termed the *line of separation*, and extends itself along the extreme margin of the living tissues; the dead parts being removed solely by actions going on in the contiguous living structures, except where they may be partially disintegrated by the pus that is thrown out.

This process of separation, commencing at the edge of the slough, which gradually loosens, slowly extends downwards to the whole depth of the gangrene; if this affect the entire thickness of the limb, the ulceration will find its way completely across it. If the slough be more superficial, the ulcerative action passes underneath it, detaching it gradually. The line of separation is usually oblique, the soft parts being first divided, and the hard tissues then ulcerated through, until the ligamentous or osseous structures are reached, which are slowly acted upon. This action is most rapid in the soft parts and in young subjects.

After the separation of the gangrenous part, a more or less ragged, irregular ulcerated surface is left, which, if not too extensive, will undergo ordinary cicatrization. As ulceration extends across the limb, the largest arteries and veins are cut through by it, without hemorrhage resulting, owing to a mass of plastic matter being poured out in their interior, and blocking them up from the line of separation to the nearest large collateral branch above it. The period required for the detachment of gangrenous parts varies according to their extent. Small sloughs may be detached in a few days, whilst many weeks are required for the separation of a limb.

Treatment.—Depressing remedies must be very sparingly used, the patient's condition being usually not of such a nature as to bear lowering. It is very easy to knock down the inflammation by energetic measures; but, at the same time, the reparative power of the system is destroyed, and the patient may not be able to rally. Inflammatory fever, however high it may be in the early stages, rapidly sinks after gangrene has set in, symptoms of an asthenic or an irritative type ensuing. Hence it is only before the occurrence and during the spread of gangrene that lowering remedies can be employed; for, when once gangrene has ceased to extend, however high the action may have been that accompanied its progress, all the powers of the constitution will be required to maintain the process of separation of the sloughs, if they be extensive and deep.

Venesection is never required in any form of gangrenous inflammation. When blood requires to be taken, *local bloodletting* should be had recourse to as a preventive means. And in this way, when conjoined with measures for *the relief of tension*, and consequently of that strangulation of the tissues which is such a fertile cause of gangrene in some forms of inflammation, it becomes an extremely important adjunct to the treatment. In these cases, free incisions into the inflamed and tense parts, by which the vessels are relieved of the blood and the tissues of effused fluids, will often prevent gangrene. This is more especially the case when loose cellular tissue, as that of the penis or scrotum, is inflamed; or, indeed, in any part in which much tension is conjoined with the inflammation. The *relief of local tension* is of the first consequence in cases of inflammation threatening gangrene. By a free incision through a structure so affected, as in phlegmonous erysipelas or carbuncle, not only may the vitality of the affected tissues be preserved, but the extension of gangrene, if it have already set in, is arrested, and the constitutional disturbance is at once lessened: the strain on the bloodvessels being taken off, the pulse falls, loses its sharpness, and great relief is afforded. In some forms of inflammatory sloughing, nature relieves the part by free hemorrhage, as from the dorsal artery in cases of acute gangrene of the penis; and it is not until this has taken place that the gangrenous action becomes arrested. By incision, also, irritant effusions and infiltrations are discharged, and thus one cause of sloughing is removed. Punctures are not sufficient for this purpose, but free incisions from two to three inches long should be made, which by gaping widely allow the escape of blood and other fluids, and thus effectually relieve tension. Mild local antiphlogistic treatment of an ordinary character is likewise required.

When the gangrene has been arrested, the fetor of the sloughs must be diminished by antiseptic applications, such as the solutions of the chlorides, carbolic acid, or charcoal and yeast poultices. The separation of the sloughs should be left as much as possible to nature, which is always fully able to accomplish this, if the patient's strength can be kept up. Any attempt to hasten this process only irritates the parts, and causes the gangrene to spread when it might otherwise have been arrested. The vitality of the tissues in the proximity of and above the line of separation is very low, and may readily be destroyed by any fresh action set up in them, there being always a danger of exciting inflammation to such a degree as to exceed that which is necessary for the adhesive, and to cause it to run into the

gangrenous form. Hence no attempt should be made to pull away sloughs not already separated, nor should stimulants be applied to the living tissues. It matters little as to what is done to parts already dead, which, when loosened, may be cut away; but we must not meddle with those that are living. Hemorrhage seldom occurs before the separation of the sloughs, but there is always danger of its happening during that process. If it occur, pressure or the actual cautery will be found the best means to arrest it; and, if these fail, ligature of the artery higher up, or amputation when practicable, might be required.

The parts that are already gangrenous should be enveloped in lint soaked in solutions of carbolic acid, the chlorides of zinc or lime, or creasote, or dusted with charcoal powder. No poultices should be applied if the sloughs be large, heat and moisture hastening their decomposition; but if they be small, yeast, carrot, or charcoal poultices may be advantageously applied.

Parts that are quite dead, but that do not readily separate, such as tendons, ligaments, and bones, may be cut through with scissors, pliers, or saws, and thus many weeks or months saved in their separation. It may occasionally be necessary in doing this to encroach on the living tissues; this should be done as carefully as possible for reasons already stated. They do not bleed much, owing to their infiltration with lymph.

The line of separation should be dresssd with water-dressing, or with some mild detergent lotion or ointment, in order to keep the surface clean and free from absorption of gangrenous matters. If sloughs be not readily separated, the balsam of Peru, either pure or diluted with yelk of an egg or very dilute nitric acid, and opiate lotions, are the most useful applications. After the separation of the sloughs, the ulcerated surface must be treated on general principles.

The *constitutional treatment* of gangrenous inflammation requires to be conducted upon the principles that guide us in the management of the asthenic and irritative forms of inflammatory fever. It should consist of attention to hygienic measures, and the moderate employment of depressing remedies, in the early stages; support of the system, by means of light tonics, nourishment, and stimulants, as the disease assumes an asthenic form; and the administration of opiates, as it sinks into the irritative type.

DIVISION SECOND.

SURGICAL INJURIES.

CHAPTER VI.

EFFECTS OF INJURY.

THE effects of an injury, if at all severe, whether it be accompanied by wound or not, are twofold, *Constitutional* and *Local.*

Constitutional Effects.—These are *immediate* and *remote.*

The *immediate constitutional effects*, or *shock*, consist in a disturbance of the functions of the circulatory, respiratory, and nervous systems, the harmony of action of the great organs of the body becoming disarranged. On the receipt of a severe injury the sufferer becomes cold, faint, and trembling; the pulse is small and fluttering; there is great mental depression and disquietude, the disturbed state of mind revealing itself in the countenance, and in incoherence of speech and thought; the surface becomes covered by a cold sweat; there are nausea, perhaps vomiting, and relaxation of the sphincters. These symptoms commonly set in immediately on the receipt of the injury. In some cases, however, there is an appreciable interval of time between the infliction of the injury and the appearance of the shock; this is more particularly the case in persons of great mental fortitude, or whose minds are actively engaged at the moment of the receipt of an injury. This condition lasts for a variable period, its duration depending on the severity and seat of the injury, on the nervous susceptibility of the patient, and on the state of his mind at the time.

Shock is partly due to *mental*, partly to purely *physical* causes. Its severity and continuance are materially influenced by the moral condition of the patient, and by the degree and nature of his injury.

In persons of a very timid character or of great nervous susceptibility, more especially in females and in children, a very trivial injury may produce an extreme degree of shock to the nervous system; indeed, the mere apprehension of injury may, without any physical lesion being actually induced, give rise to all the phenomena of shock in its most intense degree. People have been actually frightened to death, without any injury having been inflicted upon them. The state of mind at the time of the receipt of the injury influences materially its effects on the nervous system. If the patient be anxiously watching for the infliction of a wound, as waiting for the first incision in a surgical operation, all the attention is concentrated upon the coming pain; it is severely felt, and the consequent shock to the system is unusually great. If, on the other hand, the attention be diverted—if, as in the hour of battle, the feelings be roused to the highest pitch, and the mind in a state of intense excitement—a severe injury may be inflicted, and the patient may be entirely unconscious of it, feeling no pain, and experiencing no shock, not knowing perhaps that he is wounded till he sees his own blood. The severity of shock is in a great measure proportioned to the degree of pain attendant upon an injury. And, as sensibility to pain varies greatly in different individuals, so will the attendant shock.

The sudden occurrence of a severe injury will, however, induce a *physical impression* independently of any mental emotion or moral influence. Thus, if a limb of one of the lower animals, as of a frog, be suddenly crushed by the blow of a hammer, the force and frequency of the heart's action immediately become considerably lessened. Here there can be no mental impression. So in man, it is found that the severity and the continuance of the shock are usually proportionate to the severity

of the injury, either from its extent or from the importance of the part wounded. Thus, if the whole of a limb be torn away by a cannon-shot, or crushed by a railway train, the shock will be severe from the extent of the mutilation, though the part injured be not immediately necessary to life; whilst, on the other hand, if a man be shot by a pistol-bullet through the abdomen, though the extent of the injury be trifling, and merely a few drops of blood escape, yet the shock to the system will be severe, owing to the importance in the economy of the part injured. The surgeon not unfrequently employs this fact as an accessory means of diagnosis. Thus, if a man break his leg, and at the same time strike his abdomen, and the shock be very serious and long continued, without sign of rallying, the probability is that some severe injury has been inflicted upon an internal organ; injury of the viscera occasioning greater severity and longer continuance of shock than a wound of a less vital part.

In extreme cases, the depression of power characterizing shock may be so great as to terminate in death. In the great majority of instances, however, *reaction* comes on, and the disturbed balance in the system is gradually restored. Not unfrequently the reaction runs beyond the limits necessary for this, and a febrile state is induced, the pulse becoming quick, the skin hot, the mouth dry, and the secretions generally scanty. This *traumatic fever* is the invariable accompaniment of all severe injuries. It usually lasts for a few days, and then subsides, leaving no ill consequences. In severe injuries, however, occurring to persons of broken constitution, it may run into the asthenic or irritative types described at pages 92 and 93.

The *remote constitutional effects* of injuries are of a very varied character. In some cases, persons who have met with serious injury will be found to die suddenly, some months after apparent recovery. In others, they gradually fall out of health, the nutrition of the body appearing to become impaired, and anæmia and a cachectic state supervening. In other instances, again, the functions of the nervous system become disturbed; convulsive movements or paralytic symptoms of a slight but persistent character eventually develop themselves, and may become progressive, terminating in organic disease of the nervous centres. In these cases, the immediate influence exercised by the injury on the nervous system seems to pass off, while a permanent impression is left. The patient never completely recovers from the effects of his injury; he is never, to use the common expression, "the same man again;" and, although his health may appear to improve from time to time, yet, on close inquiry and careful investigation, it will be found that there has been a continuous train of symptoms indicative of a disordered state of the nervous system.

These remote constitutional effects, to which attention has been directed by Hodgkin and James, often do not manifest themselves for weeks or months after the infliction of the injury. Some change appears to be induced in the condition of the blood, or in the action of the nervous system, that is incompatible with health. Perhaps, as Hodgkin supposes, the part locally injured becomes incapable of proper nutritive action, and thus a morbid poison results, in consequence of some peculiar combination of the chemical elements of the part, by which the whole system is influenced. Be this as it may, the fact remains certain, that constitutional disturbance, serious illness, or even sudden death, may supervene as a consequence of local injury, a considerable time after its infliction.

Treatment of Shock.—If the disturbance be chiefly of a mental character, the patient will usually rally speedily on being spoken to in a kind and cheering manner, or on having a little wine and water, or ammonia, administered. If the shock be more severe, and be the result of considerable injury, the patient should be laid in the recumbent position, and the injured part arranged as comfortably as possible; he should be wrapt up in warm blankets, hot bottles should be applied to the feet, and friction to the hands and surface; a little warm tea, wine, or spirits and water, may be administered, provided the insensibility be not complete; if it be complete, the fluid should not be given, as it might then find its way into the larynx. In these circumstances, ammonia should be applied to the nostrils, and a stimulating enema administered. When there is much pain associated with the shock, a few drops of laudanum may advantageously be given. By such treatment as this, the energies of the nervous and vascular systems are gradually restored; and then reaction speedily comes on.

A question of considerable importance frequently occurs to the surgeon in these cases; viz., whether an operation should be performed during the continuance of shock. As a general rule, it certainly should be deferred until reaction comes on, as the additional injury inflicted by the operation would increase the depression under which the patient is suffering. In some cases, however, the presence of a crushed limb appears to prolong the shock, and thus prevent the patient from rallying, notwithstanding the administration of stimulants. In these circumstances, the surgeon would be justified in operating before reaction came on. Here the administration of chloroform in moderate quantity is extremely beneficial; it exercises a sustaining influence, not only by acting as a stimulant to the nervous system, but by preventing the pain and dread of the operation from still further depressing the vital energies. In these cases of long-continued shock, great care is required in ascertaining that there is no internal injury giving rise to the depression, but that the shock is really dependent upon the mangled limb.

After the immediate effects of the shock have entirely passed away, we must adopt means to prevent the remote consequences. With this view—if the patient can bear it—bloodletting is of essential service, and is, I think, far too much neglected at the present day. In addition to this, the patient's diet and habits of life should be carefully regulated, overstimulation being especially avoided; his bowels should be kept freely open, and his general health attended to. After the immediate effects of shock have gone off, the reaction which ensues may not pass the limits of health; but if the injury be severe, from its extent or from the implication of important parts, the local inflammation, which is necessary for its repair, gives rise to a general febrile state. This inflammatory fever assumes one or other of the types characterizing that which accompanies ordinary inflammation, and requires to be treated on the principles that guide us in the management of that affection.

Traumatic delirium not unfrequently occurs in cases of severe injury in individuals with an irritable nervous system; particularly in those who had been drinking freely before, or were intoxicated at the time of the accident. It usually comes on about the third or fourth day, but not unfrequently earlier than this; and most commonly declares itself during the night. This disease presents two distinct types, which are in fact different diseases—the one *inflammatory*, the other *irritative*.

In *inflammatory traumatic delirium* there are a quick and bounding pulse, hot skin and head, flushed cheeks, glistening eyes, much thirst, and high febrile action generally. The delirium is usually furious; the patient shouting, singing, tossing himself about the bed, and moving the injured limb, insensible to, or regardless of, pain.

The *treatment* of this form of the disease should be depletory. Bleeding from the arm, with leeches and ice to the head, purging and low diet, will subdue it; but in many cases it is speedily fatal.

The *irritative* or *nervous delirium* usually occurs in persons of a broken constitution, and closely resembles ordinary delirium tremens; sometimes it is preceded by a fit of an epileptic character. In this form of the disease the pulse is quick, small, and irritable; the pupils dilated; the surface cool; the countenance pale, with an anxious haggard expression, and bedewed with a clammy sweat. The tongue is white, and there is sometimes tremor of it and of the hands; but this by no means invariably occurs. The delirium is usually of a muttering and suspecting character; the patient is often harassed by spectral illusions, but will answer rationally when spoken to. This form of disease is sometimes very rapidly fatal. I have known it to destroy life in cases of simple fracture in less than twelve hours.

The *treatment* of irritative traumatic delirium consists essentially in the administration of opium until sleep is procured, or the pupil becomes contracted. For this purpose large quantities are frequently required; and the drug should be given in full doses, and repeated every second or third hour.

If there be much depression, it will usually be expedient to administer the opiate in porter, or in that stimulant to which the patient—if a drunkard—has habituated himself. The administration of the opiate should be preceded by a free purge and an aperient enema, so that all source of irritation may be removed from the intestinal canal. A strait-waistcoat is commonly necessary in all cases of traumatic delirium, in order to prevent the patient from injuring the wounded part.

After sleep has been induced, the quantity of the opiate must be lessened; but it

will be found necessary to continue it for some time, as there will be a tendency to the recurrence of the delirium at night.

These two forms of traumatic delirium, the inflammatory and the irritative, are often found more or less conjoined; a modification of the treatment then becomes requisite—the surgeon depleting with one hand, and allaying irritation by opiates and giving support with the other.

The effects resulting from injuries will be greatly modified, according to the condition of the patient at the time of the receipt of the injury, and the circumstances in which he is placed afterwards. The remarks made at page 34, in reference to the conditions that influence the result of operations, are equally applicable to those forms of surgical injury that are the result of accident, and not inflicted by the surgeon's knife; and to them I would refer the reader.

Local Effects.—The *direct local effects* of injury comprise *contusions*, *wounds* of all kinds, *fractures* and *dislocations;* these we shall immediately proceed to consider.

The *remote local consequences* of injury are not so obvious. But there can be little doubt that many structural diseases owe their origin to this cause. The nutrition of a part may be modified to such an extent by a blow or wound inflicted upon it, as to occasion those alterations in structure which constitute true organic disease. Thus we occasionally find, on death resulting some months after a severe injury, that extensive local mischief, usually of an inflammatory character, is disclosed, which has evidently been going on in an insidious manner from the time of the accident.

In other cases again, a blow may give rise to severe and long-continued neuralgic pains in a part, or it may be the direct occasioning cause of structural disease in bones, joints, or bloodvessels; and, lastly, the origin of many cases of cancer can be distinctly referred to external violence.

CHAPTER VII.

INJURIES OF SOFT PARTS.

These consist of *Contusions* and *Wounds.*

CONTUSIONS.

In a *contusion* the skin is unbroken, but there is always some laceration of the subcutaneous structures. Indeed, great disorganization of these occasionally takes place, though the skin continues entire, owing to its greater elasticity and toughness. Hence a contusion may be looked upon as being a subcutaneous lacerated wound.

In contusions there is always *extravasation* of blood into the tissues to a greater or less degree. When slight, this extravasation is termed an *ecchymosis.* Extravasation is distinguished from blood that is actually shed outwardly, in this; that in the latter case the skin is opened as well as the vessels wounded, so that the blood escapes out of the body, and it flows with a rapidity and a force proportioned to the size of the wounded vessels. In extravasation, on the other hand, the skin is either unbroken, or, if there be a wound in it, this is of such a nature as not to allow the effused blood to escape. The blood consequently accumulates under the skin in the areolar tissue, or in internal organs, presenting in the former situation the ordinary purplish-black discoloration of a bruise. The amount of blood extravasated will of course depend upon the vascularity of the part contused. The arrest of the extravasation takes place in a great measure by the effused blood pent up amongst the tissues, coagulating over and compressing the torn vessels which have poured it forth, and thus restraining the further escape of blood from them.

Causes.—Contusions may result from *direct pressure*, as when a part is forcibly squeezed; from a *direct blow*, usually by a hard blunt body; or from an *indirect blow*, as when the hip-joint is contused by a person falling on his feet from a height.

Compression of the parts injured is always necessary to constitute a contusion. This compression may occur between the force on one side, and a bone as the resisting medium on the other; or the part injured may be compressed and contused between two forces in action—as when the hand is caught between two revolving wheels; or between a force in action and a passive medium—as by a wheel passing over the limb and crushing it against the ground.

Degrees.—The amount of extravasation of blood consequent on a contusion will necessarily mainly depend upon the force employed in its production, but also to some considerable extent upon the state of health of the individual bruised. In persons out of health, with soft tissues and the blood in a low crasis, bruising very readily occurs. Contusions are of various degrees: they may be arranged as follows: 1, *of the Skin simply;* 2, with *Extravasation into the Areolar Tissue;* 3, with *Subcutaneous Laceration of the Soft Parts;* and 4, with *Subcutaneous Disorganization of the Soft and Hard Parts.*

In the *first degree*, the blood is merely effused into the skin, producing ecchymosis or bruise; the color of which varies from purplish-red to greenish-brown, being dependent upon changes that take place in the extravasated blood as it undergoes absorption.

In the *second degree* a bag of blood can often be felt fluid and fluctuating under the skin, in which state it may remain for weeks or even months without undergoing any material change, provided it be excluded from the air. In other cases it gradually becomes absorbed; or, if it communicate with the air, the bag being opened in any way, it may undergo disintegration, suppuration taking place within or around it, and the clots discharging through an abscess. In some cases it would appear, from the observations of P. Hewett and of Paget, that the clot resulting from extravasated blood may become organized and finally penetrated by blood-vessels. The French pathologists have described the formation of a cyst containing serous fluid in the site of the extravasated blood. These cysts are composed of a fibrous structure, but without cells; they have no distinct lining membrane, and in their interior serous or grumous fluid, composed of disintegrated blood, is found. In other cases the serous or fluid parts are absorbed, and the fibrinous matters, forming cheesy concretions, are left behind. Lastly, extravasated blood may give rise to a sanguineous tumor, *hæmatoma*, the blood—continuing for months, or even years, fluid, but still not unchanged—becoming darker, treacly, and more or less disintegrated, and eventually intermixed with various products of inflammation.

In the *third and fourth degrees* of contusion the laceration and disorganization of structures usually lead to sloughing and suppuration, or to rapid gangrene of the parts, or to hemorrhage, ending in fatal syncope; or, when the contusion is of an internal organ, this hemorrhage may prove fatal by taking place into the serous cavities. When the contusion is superficial, the hemorrhage is subcutaneous, and, though abundant, is rarely in sufficient quantity to influence the heart's action. In one remarkable case, however, in which a schoolmaster was convicted of manslaughter for beating a boy to death with a stick, and in which I was called to make a *post-mortem* examination, death had evidently resulted, in a great measure at least, from this cause: the subcutaneous areolar tissue of the four limbs being extensively torn away from the fasciæ, and uniformly filled with extravasated blood, whilst the internal organs were in an anæmic condition, the pulmonary vessels and the coronary arteries of the heart even being emptied of blood.

Diagnosis.—This is not always easy. The minor degrees may be mistaken for incipient gangrene, the discoloration not being very dissimilar; but the part, when simply contused, preserves its temperature and vitality. In some cases the extravasated blood has a hard circumscribed border, and is soft in the centre, thus resembling somewhat a depression in the subjacent bone. This is especially the case in some bruises about the scalp.

The diagnosis of old cases of extravasation, leading to hæmatoma, from abscess or malignant disease, is not always easily made by tactile examination only; but the history of the case, exploration with a grooved needle, and examination of the contents of the tumor under the microscope, will always clear up any doubt that may exist.

Treatment.—In the first two degrees of contusion our great object should be to excite, as speedily as possible, the absorption of the extravasated blood. Here cold applications are of especial service; lotions composed of one part of spirits of wine

to eight or ten of water should be constantly applied. Leeches—so commonly used in these cases—should not be applied to a bruised part; they cannot remove the blood that has already been extravasated, and often set up great irritation, which leads to suppuration. The bag of blood should never be opened, however soft and fluctuating it may feel, so long as there is any chance of procuring its absorption by discutient remedies. If once it be punctured and air be allowed to enter, putrefactive suppuration will be set up in it. But if signs of inflammation occur around it, the parts becoming red, hot, and painfully throbbing, free incisions should at once be made, the blood—already disorganized and mixed with pus—be discharged, and the cavity allowed to granulate. Purging and general depletory treatment will often promote absorption of the extravasation.

In the third and fourth degrees of contusion, it is generally useless to attempt to save the life of the injured part. Here poultices must be applied to hasten suppuration and the separation of the sloughs; the ulcer that results being treated on general principles.

Disorganizing contusions of the more severe kind may be recovered from, *provided there be no external wound*, even though the soft structures of the limb or part be very extensively crushed and comminuted, the bones crushed, and the joints opened. It is not the subcutaneous lacerations and disorganizations that are to be dreaded; so long as the main bloodvessels of the part injured are intact, these may be recovered from. But it is the admission of air into the interior of a badly injured limb that constitutes the great danger. If this can be avoided, there is little fear of undue inflammation being excited, provided proper precautions are taken; but if air be once admitted into the lacerated tissues, suppurative and sloughing action is at once set up, and the safety of the patient will be seriously imperilled. In such cases as these, amputation is usually the sole resource.

The difference between the effects of a subcutaneous laceration and one accompanied by open wound is well exemplified in the cases of a "simple" and a "compound" dislocation. In the first case, although the ligaments and capsular muscles are extensively torn, often with great extravasation of blood, repair takes place without any serious trouble, often with scarce any inflammatory action; whilst in the compound dislocation, where air has been admitted, the most extensive suppurative action necessarily ensues, and joint, limb, or life, one or other, is invariably lost.

Contusions of internal organs are always of a very serious character, and require special treatment, according to the part that is affected, and the extent of its injury.

Strangulation of Parts.—This, when accidental, occasionally occurs as the consequence of the application of a constricting ligature or bandage, or by the accidental slipping of a tight ring over a part. In such cases the first effect of the constriction is to prevent the return of the venous blood from the part beyond that to which it is applied; this impediment to the circulation occasions serous effusion, and hence swelling of an œdematous character. If relief be not afforded to the circulation by the removal of the constricting cause, distension of the vessels, stagnation of the blood, loss of vitality of the part, and gangrene will speedily ensue. Hence the treatment consists in at once dividing or removing the cord or ring, as the case may be. Usually this is easily done, but in some cases it is attended with no little difficulty. This especially happens when a small ring has been hurriedly put on a wrong finger, or when the penis has been drawn through a brass ring. In such cases as these the member swells greatly, and the difficulty of removing the foreign body is very considerable. The finger-ring may usually be removed by slipping a director under it, and clipping or filing it across upon this. Sometimes the following popular plan may advantageously be adopted: A strong silk thread is carefully wound round the finger as tightly as possible from the point down to the ring, and through this the free end is carried with a needle; the thread is then slowly untwisted, and the ring is thus carried upon it off the finger. Curtain or other brass rings compressing the root of the penis have been known slowly and gradually to cut through the organ, without destroying its vitality or rendering the urethra impervious. But such a fortunate result is altogether the exception; in the great majority of such cases, unless the ring be speedily cut off, mortification of the organ would ensue, and might be followed, as it has been in some instances, by the death of the patient.

WOUNDS.

A *wound* may be defined to be a solution of continuity suddenly produced by the incision, rupture, or fracture of a part.

Surgeons universally divide wounds into *Incised*, *Lacerated*, *Contused*, *Punctured*, and *Poisoned.*

Incised Wounds.—These may vary in extent, from a simple superficial cut, to the incisions required in the amputation at the hip-joint. Incised wounds are usually open, communicating freely with the air; occasionally, however, when made by the surgeon, they are subcutaneous, only communicating externally by a small puncture. They may be simple, merely implicating integument and muscle; or they may be complicated with injury of the larger vessels and nerves, or of important organs.

Symptoms.—In all cases they give rise to three symptoms; viz., pain, hemorrhage, and separation of their sides.

The *pain* in an incised wound is usually of a burning, cutting, or smarting character. Dr. J. Johnson compared his own sensations to the pain produced by a stream of melted lead falling upon the part. Much depends, however, on the extent and situation of the wound; and also whether the cut is made from the cutaneous surface inwards, or from within outwards: being greater in the former than in the latter case, owing to the section of the nerves being made from the branches towards the trunk. When the cut is from within outwards, the trunks being first divided, the branches are paralyzed, and do not feel the subsequent incisions.

The amount of *hemorrhage* necessarily depends upon the vascularity of the part, as well as on the size of the wound. The proximity of the part wounded to the centre of the circulation, or to a large vessel, also influences this very considerably—different parts of the same tissue bleeding with different degrees of facility. Thus the skin of the face pours out more blood when cut than that of the leg. The same parts will, under different states of irritation, pour out different quantities of blood. Thus the tonsils have bled, after their excision, to such an extent as to occasion death, although usually but a few drops are lost.

The *separation of the lips* of the wound depends on their tension and the position of the part, as well as on the elasticity and vital contractility of the tissues. Retraction also depends on the direction of the incision, according as this is parallel to or across the axis of a limb or muscle; as well as on the state of the parts at the time. It is greatest in those parts that are naturally most elastic or that possess the greatest degree of tonicity; thus the muscles, when cut, will retract to a distance of some inches; so also the arteries and skin gape widely when divided; whereas in the ligaments, or bones, no retraction takes place.

Union of Incised Wounds.—Incised wounds may unite in the five following ways: 1, by the direct growing together of their opposed surfaces; 2, by scabbing; 3, by the opposite surfaces uniting through the medium of coagulable lymph; 4, by granulations springing up from the sides and bottom, and covering themselves with an epithelial coating; and 5, by the growing together of two granulating surfaces. The first three methods of union are special to, and can only occur in, clean incised wounds. The last two methods may occur in incised wounds, if either of the three preceding ones fail, and are the only means by which contused and lacerated wounds can heal.

1. The *direct growing together of opposite surfaces* was termed by Hunter "*union by the first intention :*" though the term is not employed in this acceptation by modern surgeons, most of whom extend it to the union by adhesive inflammation. When wounds unite in this way, it is by the simple and direct coalescence of the opposed surfaces; and not, as Hunter had supposed, by the interposition of a layer of effused blood becoming the bond of union; or, as others have imagined, by lymph being poured out, which unites the opposed surfaces. Dr. Macartney, who pointed out the error of these doctrines, has shown that in this kind of union there is no intervention of blood or of lymph; the process consisting essentially in clean-cut parts, laid in apposition, uniting and growing together directly in the course of a few hours, without inflammation or any of its products being required to effect the union; hence he termed it "*immediate union.*"

The *conditions* necessary for direct union are the following: 1. The perfect coap-

tation of the cut surfaces; 2. A healthy constitution; 3. The absence of all inflammatory action; 4. The exclusion of all air from between the sides of the wound; and 5. A certain homogeneity of structure. It is not often in surgical practice that such a simple and direct result can be obtained; though, in some of the plastic operations about the face, we succeed in securing it. It is especially in children and young people, in whom the constitution is pure and healthy, that this kind of union is to be obtained, and after operations for the cure of deformities, as hare-lip or cleft-palate, rather than in those for disease. After some of the larger operations, in adults even, this kind of union occasionally takes place. Thus Paget records a case of amputation of the breast, in which the flaps contracted immediate and direct union with the subjacent parts; and, on the patient dying of erysipelas at the end of three weeks, the union was so perfect that it was impossible to discover by microscopical examination that any inflammation had existed, or exudative matter been poured out. In some flap operations, the surgeon may be successful in attaining union by this means. Thus, in amputations of the thigh and arm, we occasionally find that nearly the whole, or a considerable portion of the flaps are united together at the expiration of about eight-and-forty hours.

Homogeneity of structure is of especial importance in securing this kind of union. It cannot take place, for instance, between a muscular flap and the cut end of a bone. But it takes place here between soft parts corresponding in structure; and the more homogeneous this is, the more likely is union to occur. Hence it is especially easy to secure it in wounds of the face; composed as this part is of integumental structure, and cellulo-adipose and muscular tissues, pretty uniformly blended.

2. *Healing by scabbing* or *incrustation* consists in the direct adhesion of the lower part and sides of a wound under a crust of dried blood, hair, &c., which forms an air-tight covering. The absence of inflammation is necessary for healing by scabbing; if inflammatory effusion occur, the scab will be thrown off; and, air being admitted, an ulcer forms, upon which granulations will spring up. This kind of union is extremely rare in man, owing to the readiness with which inflammation is excited; but is common in the lower animals, inflammation being not so readily induced in them. This natural process is sometimes imitated by the surgeon closing a wound, as in a compound fracture, with a piece of lint steeped in blood or in collodion, under which union takes place.

The essential point in obtaining *healing by scabbing* is to secure the absence of atmospheric air from the wound, and it is in this way alone that the process can be satisfactorily accomplished. When atmospheric air gets admission to a wound on the surface of the body, decomposition usually takes place in the blood and sero-plastic fluid; and, if so, a degree of inflammatory action which is incompatible with scabbing is set up. The noxious influence of air on wounds, and its tendency to favor decomposition, was long supposed to be due to oxygen. But the recent researches of Pasteur have shown that this is not the case, but that the decomposition of fluids in wounds is due to the existence in the air of the germs of low forms of animal life. These, which are suspended in it in the form of innumerable minute particles, become deposited on any freshly-cut surface, and there give rise to decomposition and a sort of fermentative action.

Analogous to healing by *scabbing* is the process of cure in subcutaneous wounds, as in dislocations, simple fractures, and other analogous injuries; so also in the various operations of tenotomy. In these cases union takes place without any inflammation, though this is sometimes excited by the injury; the reparative material, "nucleated blastema," not being an inflammatory product.

3. *Union by the adhesive inflammation*, the "*union by the first intention*" of modern surgeons, or "*primary adhesion*," as it is termed by Paget, consisting in the effusion of lymph between the opposed surfaces, is more frequently obtained than the direct union. In order that it should take place, the following *conditions* are necessary: 1. That the patient's constitution be in a healthy state; 2. That the inflammation be restrained within such bounds as suffice for the production of lymph, but are insufficient for the destruction and degeneration of the newly-formed lymph, and its conversion into pus; 3. That the wound be closed, its side brought into accurate apposition, and the air excluded; 4. That the interposition of all foreign bodies be carefully guarded against. Blood acts as a foreign body, and prevents the coalescence of the lymph pressed out from the opposite sides of the wound; hence it is of the first importance that no blood be interposed between the opposite sides

of the wound; and adhesive union will be greatly facilitated by all oozing being allowed to cease, and by the surfaces being allowed to become glazed by the exudation of lymph for some hours before they are brought into contact. If any blood be interposed, it acts as a barrier to the cohesion of the opposite layers of plastic matter, invariably becoming disintegrated, breaking down, and being washed away by the suppuration excited by its presence; hence in the dressing of surgical wounds, such as stumps after amputation, in which it is desirable to procure union by adhesive inflammation, the cut surfaces should not be brought together for a few hours, until all oozing of blood has ceased, and the fibrinous layer thrown out.

The union by adhesive inflammation in an incised wound takes place in the following manner. After all hemorrhage has ceased, the surface becomes "glazed," being covered with a film of fibrine of the liquor sanguinis, with which a large quantity of white corpuscles are found intermixed; a sero-sanguinolent fluid draining away. This layer of fibrine rapidly becomes thickened by the deposit of exudative matter, and ultimately becomes vascular, undergoing development into fibro-areolar tissue, which constitutes the bond of union, its exposed surface becoming gradually covered by an epithelial layer, as has already been described in speaking of the development of lymph and its cicatrization. The adhesive layer forms with varying rapidity on different surfaces; thus in a stump, after amputation, it will be found that the muscles, fasciæ, and areolar tissue are covered with fibrine in the course of a few hours; it is not until about the third or fourth day that the subcutaneous fat becomes coated in the same way; and eight or ten days elapse before the adhesive lymph is thrown out upon the cut surface of the bone; and here it shows itself first on the medullary canal, afterwards on the cancellous texture, and lastly upon the hard bone.

For the production and organization of this lymph a certain amount of inflammation is absolutely necessary, but the inflammation must be confined within proper limits. An inflammation that is too intense, or too long continued, is destructive to the adhesive process. If too long, the adhesive will pass into the suppurative inflammation; and if it be too long continued, the development of lymph will be interfered with; for, though inflammation be necessary for the formation of the bond of union, none is required for its organization, or for its ultimate development into fibro-areolar tissue. (The subject of adhesive inflammation is fully treated at pp. 107 to 109.)

4. *Granulation.*—In those cases in which union by direct cohesion or by the adhesive inflammation fails, in consequence of the broken state of the patient's health, or of some local disturbance, as by the interposition of blood or other foreign body, by the excitation of undue inflammation, by the wound being left open to the air, or by any other disturbing cause, granulations are thrown out, and union by "*the second intention*," as it is termed, occurs; and we may often see in the same incised wound one portion healed by direct union, another part by the adhesive inflammation, and the remainder by granulation. Union by granulation, or the second intention, is identical with the process of the repair of ulcers; and to the description of this (p. 116) I must refer the reader. A layer of plastic exudation is deposited, which gradually increases in thickness; becoming vascular, it accumulates in masses of pointed and ruddy granulations, throwing off pus and effete corpuscles from its surface, and developing in the deeper parts into fibro-areolar tissue, whilst the more superficial portion undergoes epithelial transformation.

5. *Union of Granulating Surfaces.*—It not unfrequently happens that, although granulations have sprung up, union between the opposed surfaces has not taken place. We must endeavor to accomplish this, by bringing the granulating sides of the wound together, when they will cohere, thus constituting union by "secondary adhesion." In some amputations, and in many plastic operations, cases of hare-lip, cleft-palate, &c., this mode of union is occasionally established.

Management of Incised Wounds.—In the treatment of an incised wound, we must always endeavor to procure union directly or by adhesive inflammation between a portion, if not the whole, of the surfaces; if union in this way be obtained, we save the patient much time and trouble.

The probability of procuring adhesive union depends greatly upon the constitution of the patient, as well as on the management of the wound. It is a grave error to suppose that the probability of obtaining union by the first intention is entirely dependent on local conditions, and on the management of the wound itself. It

depends far more on the constitution of the patient than is usually admitted. In many constitutions, it is impossible under the most favorable circumstances to obtain it. The sounder the constitution, the more readily will union by the first intention take place; and, in all cases, it is disposed to by the removal of all sources of irritation from the system. Thus in those operations, the plastic, for instance, in which it is necessary that the union be as direct as possible, the constitution of the patient should be prepared by his being kept for some time previously upon a nourishing but unstimulating diet, chiefly consisting of milk and light animal food, by his having regular exercise, and by the administration of iron; we should also look specially to the state of the digestive and urinary organs, and remove any source of irritation in connection with them. In cases of accidental wound, if we wish to secure union by the first intention, we must keep the patient quiet, and employ a moderately antiphlogistic regimen, avoiding especially all stimulants, which have a great tendency to interfere with this desirable result. It must be borne in mind, that the great object is to limit inflammation; if this be carried beyond what is necessary for plastic effusion, suppurative action will certainly occur. With regard to local antiphlogistic treatment, nothing is required beyond simplicity of dressing, and keeping the part cool by means of wet lint, or, if the wound be very extensive, and inflammatory action threaten to run high, by irrigation (Fig. 52). In producing union by the first intention, much will depend upon the homogeneity of the tissues of the opposed surfaces. When these are soft and uniform in structure, as in the face or the perinæum, union will readily take place when the cut surfaces are brought together. But if they be very dissimilar, we cannot expect such union: thus muscle will not adhere to cartilage, nor tendon to bone.

Treatment.—There are three great indications in the local management of an incised wound.

The first is the *arrest of hemorrhage.* If the bleeding be general from the surface, it may be stopped by position, by coaptation of the sides of the wound, and by the application of cold and styptics. If it be arterial, ligature, torsion, or acupressure to the bleeding points will be required.

The next indication consists in the *removal of foreign bodies* of all kinds; such as dirt, pieces of stone, glass, &c., including coagulated blood, from between the lips of the wound. In doing this, care should be taken not to wipe the wound too roughly; a piece of soft lint, a triangular bit of sponge, or a stream of cold water poured over the surface, should be the means employed.

The last and most important indication to fulfil, is the *coaptation of the opposed surfaces and the exclusion of air* as accurately as possible. This can only be maintained by attention to position, and by the application of sutures, plasters, and bandages.

As a general rule, the sides should not be brought together until all hemorrhage has ceased. If, however, there be but slight oozing, this may be arrested by the approximation of the surfaces. If the wound be extensive, it may be advantageous to wait for a few hours, until its sides are glazed over by a layer of fibrine. The parts should now be brought gently into contact, due attention being paid to relaxing them as much as possible by position, so that there may be no gaping of the lips, nor tension on the sides of the wound. They must be kept in place by sutures, plasters, and bandages. The exclusion of air from a wound that it is intended to unite by primary adhesion is of the first importance. Whether air acts directly in favoring the decomposition of the sero-plastic fluid that is effused on the cut surfaces, or whether, as Pasteur and Lister suppose, it is the medium by which organisms are conveyed by which fermentative action is set up, in reality matters little; for the fact is certain that, unless it be excluded, suppuration will be set up.

Sutures are commonly employed when there is more tendency to gaping than can be overcome by position or plasters. The material that is generally used for this purpose is well-waxed dentist's or twisted silk of various degrees of fineness, introduced by means of a curved needle. In certain operations, more especially those of a plastic nature, where the suture has to remain in the tissues for many days, and in which, if thread or silk be used, the material would either be decomposed or would imbibe the secretions of the part or wound, and thus become a source of irritation, acting like a seton, various metallic wires, of gold, silver, iron, or lead, are occasionally employed with advantage, instead of silk. Well-annealed silver or iron wire is that to which most surgeons give the preference. In wounds

of the limbs, especially in those cases in which some traction may be expected, the suture should be thick; whilst in those cases in which it is of importance that as little deformity as possible be left, it should consist of the finest material that is compatible with the requisite strength.

Sutures may be of various kinds: the *interrupted*, consisting of a number of single stitches, applied at distances varying from half an inch to an inch and a half, is the one most commonly had recourse to in all cases involving the integument. In applying this suture the needle should never be carried deeper than the integumental structure, except in some of the parts about the face, such as the lips and eyelids. The suture should be tied by means of the reef-knot, and the ends be cut short.

The *continuous* suture, never used on the cutaneous surface, is principally employed in incised wounds of the intestines.

The *quilled* suture is applied in cases, as in rupture of the perinæum, in which the sides of a deep wound are required to be brought into contact throughout. It consists of a double interrupted suture passed deeply, and tied tightly over pieces of elastic bougie, laid parallel to, and at the distance of half an inch from, the edges of the wound.

The *beaded* suture is rarely employed at the present day: in it the knot is made over a large bead, or a split shot, strung upon each side of the suture, which thus diffuses the pressure over a greater extent of surface.

The *twisted* or figure-of-8 suture is very commonly employed in surgery; it consists in the introduction of a slender pin, made of soft iron, with a steel point, across the lips of the wound, and the application of soft silk-twist over this in the manner of a figure of 8; care being taken not to draw it too tight, or to compress the soft parts between the needle and suture, lest sloughing result.

Sutures, of whatever kind, act as irritants along the track through which they are applied; hence they should always be withdrawn as soon as they have accomplished their object—that of procuring union of the opposed surfaces. Every minute that they are left in beyond this is detrimental to adhesion, and is attended with a risk of the excitation of undue action. In general, they should not be left in beyond eight-and-forty hours; but in some cases, more particularly when made of metallic wire, they may advantageously be retained for a considerably longer period—for six, eight, or ten days. At last even these will produce ulceration. When they are withdrawn, care should be taken not to disturb the adhesion in their neighborhood by improper traction.

The *serrefine* (Fig. 57) may be used in some cases, especially when very accurate union of the lips of a wound is required, as in cuts upon the face.

Fig. 57.

The serrefine.

Plasters serve to maintain the approximation of the opposed surfaces. They are of various kinds; but the resin, soap, and isinglass plasters are those that are most commonly employed. Each of these possesses peculiar properties that fit it for particular cases. The resin plaster has the advantage of being the most adhesive, and of not being readily loosened by discharges; but it is irritating, sticky, difficult to remove, and, in consequence of the lead that it contains, leaves a dirty-looking incrustation on the part. The soap plaster is less irritating, but at the same time is less adhesive, and is consequently seldom employed in the treatment of wounds. The isinglass plaster is doubtless the most cleanly and least irritating of all; and, being transparent, possesses the advantage of enabling the surgeon to see what is passing beneath it. It has, however, the disadvantage of being readily loosened by the discharges of the part, or by the necessary dressings.

The plasters should be cut into strips of sufficient length to support the sides as well as to compress the edges of the wound, and should be applied between but not upon the points of suture, all hairs having been removed from the part on which they are laid down, and the surface being thoroughly dried. In removing them, both ends should be loosened at the same time, and the strip thus taken off without either lip of the wound being unduly dragged upon.

Collodion or *styptic colloid* may often be advantageously used instead of plasters, either alone or in addition to sutures, being painted over the wound with a camel's-hair brush, and thus bringing the lips into more accurate coaptation at the same

time that it excludes the air, and thus tends to heal the wound by a subcutaneous process.

[The gauze and collodion dressing of Dr. Goddard, already referred to, will be found an admirable means of approximating the edges in many cases of incised wound. The gauze should be cut in strips about an inch wide and four inches long, and one end should be made to adhere tightly before the other is drawn across the wound. Dr. Hewson has substituted a thin and flexible lead ribbon for the ordinary silk gauze, and in several cases at the Pennsylvania Hospital, used it with very good results. I have myself tried this modification of Dr. Goddard's dressing, but confess to have been disappointed in its employment. It is extremely difficult to make the lead ribbon adhere firmly to the skin, and it can never be made quite so flexible as the gauze, which is sufficiently unirritating for all practical purposes.—A.]

After coaptation has been effected by position, aided by the application of sutures and plasters, a strip of water-dressing may be laid along the line of the wound, and a piece of wet lint over the whole surface, which should be kept as cool as possible. If any ligatures have been applied to bleeding vessels, they must be left hanging out at the most dependent angle. The first dressings should be left unchanged for two or three days; the sutures may then be removed, and the plasters as they become loosened; care being taken to support the sides, and after a time to bandage the part properly by circular turns of a narrow roller. In many cases, the direct union of clean cut wounds may be much facilitated by bandaging the part, so that firm pressure is exercised upon it from the very first. This requires to be done carefully and with due attention to the proper support of the deeper parts, lest infiltration of sero-sanguinolent fluid occur in them, which will readily lead to suppuration.

Union may be readily accomplished in many slight incised wounds, by covering the edges of the cut with a piece of soft lint soaked in collodion; direct cohesion, by a process analogous to scabbing, taking place under this dressing.

If union by the first intention fail from any local cause, or if the wound occur in such a constitution that it is useless to attempt it, inflammation takes place in and around it; the lips swell and become red; a sero-sanguinolent discharge, gradually assuming a puriform character, exudes; and at the same time, if the wound be an extensive one, suppurative fever sets in. Under these circumstances, the sutures should be immediately removed: the strips of plaster, if continued, should be used merely for support and not for union; a large soft linseed-meal poultice, or a thick piece of warm water-dressing, should be applied; and the patient put upon a moderate antiphlogistic regimen. When suppuration has fairly set in, and granulations have sprung up, the treatment must be conducted in accordance with those general principles that guide us in the management of ulcerated surfaces. The suppuration must be moderated, the process of cicatrization facilitated by the application of a bandage, the general health attended to, and the strength of the patient supported.

Union by "secondary adhesion" may sometimes be accomplished, after that by the first intention has failed, by bringing the granulating surfaces together a second time by means of sutures, hare-lip pins, or plasters.

Faulty cicatrices often give rise to great disfigurement, and require some operative means to remedy this inconvenience. These *plastic operations* will be described more fully hereafter; but it may be stated here that much benefit will occasionally result from excising the cicatrix, and then bringing together the opposite edges of the wound in an uniform line. Should it be too large for this, if flat, it must be left; but if angular, it may be divided down to the sound structures beneath, and the gap thus resulting filled by a flap of integument dissected up from the neighboring parts and twisted into it.

Contused and Lacerated Wounds.—These may be defined to be wounds that are conjoined with more or less bruising about the edges and sides; presenting every possible variety in the degree of contusion and of wound, from a cut on the shin to a limb crushed and lacerated by a cannon-shot. They are commonly inflicted by blunt cutting instruments, as by a hatchet, or by stones, bludgeons, &c. Lacerations by machinery, in which parts are torn off or crushed, the bites and gorings of animals, and gunshot injuries of all kinds, come under this denomination.

Characters.—Whatever their mode of infliction, these wounds present certain characters in common, by which they differ from all other injuries. Their lips are irregular and torn, less gaping than in incised wounds, but surrounded by more or less ecchymosis and contusion, with a tendency to slough at their sides. There is usually but little hemorrhage, and the pain is of an aching or dull character. In consequence of the sloughy state of the lips and sides, these wounds always unite by the second intention.

Contused and lacerated wounds present peculiarities according to the mode of their infliction.

When they are occasioned by the bite of a large animal, the part injured becomes very painful, and inflames extensively; the wound being lacerated, much contused, and often penetrating deeply. It sloughs in consequence of the pressure to which it has been subjected, and of the animal having shaken and torn the part seized. When the wound is inflicted by the tusk or horn of an animal, it is extensively lacerated rather than contused, and often partakes of the nature of a punctured wound.

When a part of the body is torn off, the wound presents peculiar characters; which differ, however, according as the separation is effected at the part struck or seized, or at a distance from it.

In the first case—as when a cannon ball carries off a limb, or an arm is caught in a steam-mill or rag-tearing machine and crushed or torn off—the stump presents a very ragged surface, the skin being stripped away higher than the other parts, the tendons hanging out, and the bellies of the muscles that are torn across being swollen, protruding, and apparently constricted by the lacerated integument. A most important condition in these wounds is the state of the vessels; these are separated lower down than the other parts, for, being elastic, they elongate and pull out before they give way. There is no hemorrhage, because the inner and middle coats of the artery, breaking off short, retract and contract to a small aperture, and allow the external one to be dragged down and twisted over its mouth, in such a way as to offer a complete barrier to the escape of blood. The bone is crushed off at the end of the stump, of which it forms the irregular conical apex, and is often split up to the next joint above.

[In a case in which the thigh was entirely torn off about its middle, I found the great sciatic nerve hanging fifteen inches from the stump, having given way below its division in the popliteal space. The patient lived a little over twelve hours from the time of the accident, and no marked pain was elicited by handling the nerve, though the skin of the stump was acutely sensitive. (*Proc. Path. Soc. Phila.*, in *Am. Journ. Med. Sciences* for Oct. 1863, pp. 409-10.)—A.]

Occasionally, when parts are pulled off, they are separated at a distance from the point seized. Thus, fingers that have been torn off by machinery have their extensor tendons separated higher up, at their junction with the belly of the muscle, and not at the part seized; the tendon being drawn out of its sheath, and hanging on to the separated end in a ribbon-like manner.

In the *progress* of a contused or lacerated wound there are two distinct periods: 1, that of the separation of the slough, produced by the contusion; and 2, that of repair by granulations of the chasm left. These processes are analogous to those which occur in ulceration, and are fully described at page 116.

The *extent of the slough* depends not only upon the extent and severity, but also upon the situation of the injury. If the parts around the wound be much bruised, then superficial sloughing to a great extent may occur; if the wound be deep though not extensive, there will always be danger of troublesome sloughing, leading to deep suppuration and burrowing of matter, and in some cases to secondary hemorrhage. Those wounds that are situated immediately over bony points—as the shin and elbow—are especially tedious, as the slough frequently implicates the fasciæ. The scalp has a less tendency to slough than any other part of the cutaneous surface. This is owing to its great vascularity, and to the large supply of blood which it receives from closely subjacent arteries. In all cases of contused and lacerated wounds—more especially in those of the scalp—there is great danger of the supervention of erysipelas.

But the chief danger to be apprehended in wounds of this description is the supervention of *traumatic gangrene*, which may occur in three ways.

1. The contusion always kills a thin layer of tissue, which forms a slough on the

sides or lips of the wound; but in some cases the violence done to the part is so great as directly to kill its whole substance. Thus, if a limb be crushed to a pulp by machinery, or by the passage of a heavy wagon over it, all circulation is completely and at once arrested, the vitality of the part is destroyed outright, and it will speedily fall into a state of putrefactive decomposition, with all the usual signs of advanced mortification. If the violence be not quite so great as this, the vitality of the part may be lessened and its resisting power diminished to such an extent, that the inflammation necessary for the repair of the injury terminates in gangrene. This is a local traumatic mortification, evincing no disposition to spread beyond the part injured, but being bounded by a line of demarcation along which it will separate. It is not always easy to distinguish this direct form of gangrene from such discoloration and disorganization of a limb as is still compatible with life. In all cases of doubt the surgeon must wait, and a very short time—a few hours—will be sufficient to declare whether the vitality of the part can be maintained or not. In cases of much doubt an incision might be made into the part, and the true state of things thus ascertained: but this should not be done if it can possibly be avoided.

2. The injury may be chiefly inflicted upon the great vessels of the limb, damaging them to such an extent as to interrupt completely the circulation; gangrene being thus induced indirectly in the parts supplied by them. This form of gangrene we shall have occasion to treat of fully when speaking of Injuries of the Arteries.

3. The true traumatic or "spreading gangrene," the most fatal variety of mortification, is most commonly the result of severe contused and lacerated wounds particularly when complicated with fractures. It has a tendency to spread rapidly, especially through the cellular planes of the limb, often involving the whole member in less than twelve hours after its invasion.

The true *spreading traumatic gangrene* is invariably of the dark and humid kind. In it, death of the tissues and their putrefaction are contemporaneous. The putrefactive process does not take place in this, as in the other varieties of gangrene just described, some hours, or days even, after the cessation of vitality in the part; but the purplish-black color, the fetid odor, and the development of gas, occur at the moment of the death of the tissues, and are evidently dependent on some peculiar septic condition of the parts attacked by the disease. It differs from the other varieties of gangrene in having no disposition to limit itself by a line of demarcation, as well as in the rapidity of its extension and the speedy putrescence that occurs in the part attacked.

The *causes* of this form of traumatic gangrene are local and constitutional combined. The *local causes* consist of injuries, more particularly contused and lacerated wounds of the hand or foot. As a general rule it may, perhaps, be stated that the more severe forms of injury of this description, more especially such as implicate joints or bones, are more liable to be followed by this form of gangrene; but it would be an error to suppose that severe injury is a necessary precursor of it. Comparatively slight injuries, provided they be of the nature of lacerated wounds, have not unfrequently been the occasioning cause of traumatic gangrene of the worst form.

The *constitutional condition* of the patient is undoubtedly the main cause of the supervention of spreading traumatic gangrene. However severe an injury may be, and however certainly it may kill those tissues or that part of a limb which are directly and immediately exposed to the operation of the external violence, the rapidly spreading form of the disease will not supervene unless the constitution be in an unsound state; and this remark applies necessarily with especial force to its occurrence after the slighter forms of injury. The supervention of spreading traumatic gangrene will occur in circumstances similar to those which dispose to pyæmia, erysipelas, or sloughing phagedæna; and, in fact, to the low and diffuse inflammations generally. They consist of imperfect and faulty hygienic conditions, and an impure state of the blood, arising either from long-continued exposure, antecedent to the injury, to such conditions, or to chronic disease of the eliminatory organs, more particularly of the kidneys. Defective depuration of the blood, consequent on chronic kidney-disease, is a most fertile cause of this as of the other forms of gangrene. Indeed, I believe that the true spreading traumatic gangrene cannot occur unless the blood is, *previously* to the receipt of the injury, in a depraved and disordered state, the result of the conditions, singly or combined, above mentioned. Hospital miasmata, and exposure to faulty hygienic conditions after the receipt of

the injury, do not appear to me to exercise so marked an influence on the occurrence of this form of gangrene as of the low inflammatory diseases of the erysipelatous type. In fact the patient is rarely, if ever, exposed to these influences sufficiently long after the occurrence of the injury for them to have much effect on his constitutional condition, had that been in a sound state previously. Spreading traumatic gangrene occurs only in recent wounds, and usually manifests itself within the first three days after their occurrence, whilst they are still in their first stage, and before suppurative inflammation has set in. When once this has occurred, and especially if the wound be granulating, the patient may get erysipelas, or pyæmia, or sloughing phagedæna; but he will no longer be susceptible of the spreading form of traumatic gangrene. I cannot, therefore, but look upon this formidable disease as a truly constitutional affection, depending more upon the state of the patient's blood at the time of the reception of the injury, than upon the severity of that injury, or upon the circumstances to which he has been exposed immediately after the receipt of it.

The *symptoms* are as follow. The wounded limb at the seat of injury swells, with some dusky redness, and a deep-seated, tensive, burning pain. The swelling, redness, and tension spread upwards, and are speedily followed by a dusky purplish tint, by a soft doughy feeling of the parts, and in the course of a few more hours by a deep blackish-purple discoloration, which spreads uniformly and with great rapidity through all the tissue affected. This is accompanied or immediately followed by emphysematous crackling from gases, the result of putrefaction, which are developed in the parts attacked by the gangrene. The changes, which are of a putrefactive character, first develop themselves in the wound itself, and speedily extend from it to the surrounding parts. That portion of the limb which is below the gangrened part becomes pale, cold, and œdematous. The portion which is above becomes rapidly infiltrated by serous exudation, which runs up the inner side of the limb to the axilla or groin, as the case may be. The part immediately above the limit of the tissues that are actually mortified is greatly swollen by œdematous infiltration, tense and pitting slightly, usually mottled in color of shades of greenish or grayish-yellow, like a bruise that is passing off. This œdema and peculiar discoloration extend higher along the inner side of the limb, where it always first reaches the trunk. Emphysematous crackling rapidly spreads itself along the same parts, and the gangrene here travels with great rapidity, hopelessly involving the tissues and entering into the cellular planes of the axilla or groin in a very few hours. As the gangrene advances, the parts affected fall into a soft, pulpy, black mass.

On making an incision into the parts so affected, it will be found that the gangrenous disorganization is primarily seated in the cellular planes of the limb, and that the muscles are not affected in the first instance. It will also be observed that the disease extends itself through the areolar tissue, the skin falling secondarily into slough.

The constitutional symptoms are throughout of the lowest ataxic type; and death almost invariably ensues in from three to four days after the invasion of the disease, and always very shortly after the gangrene has reached the trunk.

Treatment of Contused and Lacerated Wounds.—In the treatment of the slighter form of these injuries, we must bear in mind the occurrence of the two distinct periods: 1, that of sloughing; and 2, that of granulation. There is also in all injuries of this description a special tendency to the occurrence of erysipelas and allied diseases.

Care must be taken to clean the parts thoroughly from foreign bodies that are frequently impacted or ground into them. However contused and torn a flap of skin may be, it should, as a general rule, never be separated, provided it maintain any attachment to the neighboring tissues, but always be replaced on the chance of its vitality being preserved. If it live, as it will often do, especially about the scalp, under apparently the most discouraging circumstances, much will be gained; if it slough, no harm can result from the attempt to preserve it. There are even cases on record in which parts that have been completely separated have become attached, by being immediately reapplied to the surface from which they had been torn. Whether this be actually the case or not, it is at all events certain that a very small tongue of skin is sufficient to maintain the vitality of a part. This we see exemplified in the operation for the restoration of a lost nose; and cases have

occurred to me in which the nose, nearly cut off, being only retained by a portion of one ala, has readily united on being replaced; so likewise, in bad cases of compound dislocation of the fingers, the part has been saved, though merely attached by a narrow bridge of skin. After a part has been replaced in this way, it should be retained *in situ* by a few points of interrupted suture, with a piece of lint soaked in collodion applied to the line of wound. The sutures must be left in for a somewhat longer time than usual, until good union has resulted.

[Great caution must be exercised in applying sutures in cases of lacerated and contused wounds, lest the subsequent swelling produce so much tension as to cause sloughing. I have more than once seen large surfaces of skin lost through the over diligence of the surgeon in the use of sutures.—A.]

In ordinary cases of contused or lacerated wounds, whether superficially extensive or deep, we must facilitate the separation of the sloughs by the application of *poultices*, which also serve to subdue local inflammation.

[The experience of American surgeons is decidedly opposed to the employment of poultices in recent cases of contused wounds. Cold or tepid water, if its application be carefully watched, answers a very good purpose in many cases, and is of course recommended by its simplicity and cheapness. The dressing which I myself am in the habit of employing, is laudanum either pure or diluted with a variable amount of water. It may be applied as a warm fomentation, covered with oiled silk or waxed paper, and will be found very soothing to the patient, and in every respect satisfactory.—A.]

Disinfectants should be freely used in all contused and lacerated wounds. They must be washed and syringed out several times a day with weak solutions of the chlorides, of the permanganates, or of carbolic acid. In this way sloughs and decomposing pus may be got rid of, and the tendency to local inflammation of an erysipelatous character, and the development of pyæmia, averted. There is no more fertile cause for these disastrous effects than the retention amongst the areolar tissues of a contused wound of fetid decomposing pus.

About the period at which the slough begins to be loosened, there is danger of the occurrence of hemorrhage, if a large artery have been implicated in the injury. When hemorrhage occurs in this way, it usually sets in from the sixth to the twelfth day, and may be speedily fatal. After the sloughs have separated, an ulcer is left, which must be treated on general principles.

Amputation.—In the more severe cases of contused or lacerated wounds, any attempt at saving the part may be hopeless, and the patient's only chance lies in *amputation*. In determining the expediency of operation, two questions present themselves: 1. The nature of the cases in which amputation should be performed; and 2. The time at which it should be done, whether immediately after the infliction of the injury, or subsequently.

It is difficult to lay down more than very general rules as to the *kind of cases that require amputation;* much depending on the age, constitution, and previous habits of the patient. In all cases the surgeon should be careful not to condemn a limb that admits of a fair chance of being saved; and, if the patient should happen to die, as he often may, from the after-effects, such as erysipelas or phlebitis, of a contused wound that admitted a fair prospect of recovery, the surgeon may justly console himself with the reflection that, with the constitutional disposition leading to these diseases, the injury inflicted by the amputation would in all probability have been equally fatal, and that thus the patient has been saved the pain of an operation that would have been unsuccessful in its result.

As a general rule, severe injuries are more readily recovered from in the young than in the old, their vitality and elasticity of constitution being greater, with less tendency to consecutive diseases. Much will depend upon the habits of the patient, or upon the existence of visceral disease at the time of the injury. In persons who have been free livers, and who have that peculiar irritability of system conjoined with deficient power so commonly observed in such subjects, and more especially if there be already existing disease of the liver or kidneys, contused and lacerated wounds are apt to be followed by the worst forms of erysipelas and traumatic gangrene, and thus to be speedily fatal. Injuries of the upper extremity are less serious than those of the lower; its supply of blood being proportionably greater and more uniformly distributed. In some badly contused wounds, also, of the arm and hand,

as in bad lacerations with fracture about the shoulder, elbow, or metacarpus, resection of the injured part may be performed instead of amputation of the limb.

Though there may be always this doubt as to the cases that should not be amputated, there are certain conditions in which the surgeon need never hesitate to perform this operation, as the only chance of saving the patient's life. The following are the cases of severe contusion and laceration in which the limb should be amputated; either with the view of preventing the occurrence of gangrene, or in order to remove a mortified part from the body, and thus to save the life of the patient at the expense of the injured limb.

1. If a limb have been torn off by machinery, carried away by a cannon ball, or cut off by the passage of a railway train over it, the irregular and conical stump should be amputated, so as to leave a more useful and healthy one to the patient.

2. If the whole thickness of a limb—the soft parts and the bones—be thoroughly disorganized and crushed, it must be removed.

3. If the soft parts be extensively stripped away from the bones, though these be entire, so much sloughing and suppuration would ensue as to leave a useless limb, and amputation should be performed. It is in these cases that it is often especially difficult to estimate the amount of injury that cannot be recovered from, this depending so much upon the age and constitution of the sufferer. I believe that surgeons, in their anxiety to save a limb, often lose a patient under these circumstances. I have more than once had reason to regret having attempted to save limbs injured in this way; and believe that, if the skin of the lower extremity be extensively torn down and the muscles much lacerated, so as to slough away, there is but little chance for the patient—unless he be very young, and of a remarkably sound constitution—except in amputation. In the upper extremity it is different; there, recovery may take place under the most adverse circumstances.

4. If the bones be extensively comminuted and crushed at the same time that the soft parts are much lacerated, there can be no question about the propriety of removing the limb.

5. So also, if the knee be largely opened, with laceration of the soft parts, and perhaps fracture of the contiguous bones, the limb must be amputated. Corresponding injuries of the ankle, shoulder, and elbow joints, may, as has already been stated, admit of resection rather than of amputation.

6. Bad crushes of the foot have a great tendency to run into gangrene, and hence require amputation. In the hand, on the contrary, very extensive injuries are often recovered from, without this operation being necessary; and in many cases partial resection may be substituted for it.

7. In those cases in which a large artery, as the femoral, is lacerated at the same time that the soft parts are extensively injured, and the bone fractured, amputation is required in order to prevent the occurrence of gangrene. In the more local form of traumatic gangrene, in which the disease is confined to the part directly crushed and injured, no good can come of delay, and amputation should be performed as soon as mortification has declared itself; and the limb must be removed at a sufficient distance from the seat of mischief. Thus, if gangrene of the foot or ankle come on in consequence of a smash of these parts, the upper part of the leg or thigh should be amputated. When the mortification results indirectly from injury of the vessels, the limb should also be immediately removed in a line with the wound, unless this be too high up; then the most favorable point must be seized, as will hereafter be explained. Amputation under these circumstances is by no means a very unfavorable operation (and it is one that I have several times successfully performed), provided it be done sufficiently early, before the constitution becomes poisoned by the absorption of morbid matters from the gangrenous limb. It is scarcely necessary to warn the surgeon to be certain of the existence of gangrene before he operates; and also that it be not a mere limited slough, but sufficiently extensive to jeopardize the patient's life.

8. In all cases in which the *true traumatic* or *rapidly spreading gangrene* has set in, the surgeon will be placed in a great difficulty, whichever way he act. If he trust in constitutional treatment, in the hope of a line of demarcation forming, he will almost certainly be disappointed, the gangrene rapidly spreading up to the trunk; and if he amputate, he may probably lose his patient by the stump becoming affected. Yet amputation should, in my opinion, be performed at once. For, although this operation is necessarily very unfavorable when practised in these

cases, in consequence of the gangrene not being a local affection, but dependent on constitutional causes, yet it must be remembered that, if the surgeon wait for the line of demarcation, or trust to other means, such as incisions or general treatment, the patient will almost to a certainty die. The patient's safety in these cases, then, lies in amputating early, and removing the limb high above the part affected; thus, in spreading gangrene of the arm, at the shoulder-joint; and of the leg in the upper part of the thigh. The necessity for high amputation in these cases is owing to the gangrene spreading more extensively in the areolar tissue than it does in the skin; and hence in reality invading the limb to a higher point than it appears externally to do. In most cases it will be found that the infiltration precursory to the gangrenous mischief runs up one side of the limb—the inner or posterior—to a much greater extent than the other. In amputating under such circumstances the surgeon may often very advantageously so fashion his flaps as to exclude as much as possible of the affected part or side of the limb, forming them chiefly from that least affected. A principal source of danger and of death, after amputation in these cases, is the great disposition to the recurrence of the morbid condition in the stump, more particularly in the lower extremity. Out of twelve cases in which I have seen or done amputation for this disease, this recurrence happened in seven instances. This tendency will be increased by the proximity of the line of amputation to the gangrenous limit. But, even under the most unfavorable circumstances, recovery will sometimes take place. Thus I have seen the flaps in amputation for spreading gangrene infiltrated with gelatinous-looking fluid, and yet recovery take place. In a man whose arm I amputated at the shoulder-joint for spreading gangrene of the limb, the infiltration had extended as high as the scapula; yet he made a very excellent recovery. In the lower extremity the liability to recurrence of the gangrene is, however, very much greater; and there can be but very little prospect of saving the patient if the thigh have once become reddened and infiltrated, even though the gangrene do not extend above the knee—invasion of the stump ensuing under such circumstances with almost absolute certainty.

Much of the success of the case will depend on the after-treatment. Light dressings to the stump, the administration of full doses of liquor opii, and the early and free administration of stimulants, more particularly brandy and wine, are the principal points to be attended to; and attention to these will often bring the patient through, though usually not without much difficulty and great constitutional disturbance.

The next question, as to the *period* at which amputations should be performed in contused wounds, has already been considered at pp. 61 to 64. It may be generally stated that, the sooner a condemned limb is taken off, the less is the suffering, and the better the chance of recovery to the patient; and that, consequently, primary amputation should be practised in these cases; for, notwithstanding the higher rate of mortality in primary than in secondary amputations, it is absolutely necessary in many cases to remove the injured limb within the first twenty-four hours. This higher mortality may partly be dependent on the accidents that require primary amputation being more severe than those in which it has been thought justifiable to attempt to save the limb; and certainly, of the two alternatives of leaving a badly crushed and mangled limb until suppuration has set up, and thus exposing the patient to all the risks of gangrene, erysipelas, pyæmia, &c., or removing it at once, the latter is the one attended with least danger to the patient.

A limb is sometimes so severely and hopelessly crushed and torn that any attempt at its preservation must be useless; whilst at the same time the patient is so severely injured internally, or is so prostrated by the general shock to the system, that amputation as a formal operation would be as useless as it would be unjustifiable, the patient having at most, perhaps, but a few hours to live. In these circumstances the best thing that can be done is to put on a tourniquet tightly so as partly to restrain hemorrhage, partly by the pressure of the hand to restrain the painful quivering of the muscles, and to wrap up the maimed limb in a wet cloth. Should it have been nearly completely detached—merely hanging on by shreds of the lacerated muscles—these may be divided, and thus its removal effected without additional shock or suffering to the patient.

Brush-Burn.—There is a peculiar species of wound, that partakes perhaps more of the character of those that we have just been considering than of any other variety, occasioned by rapid and severe friction of the surface of the body, so that

the skin becomes abraded and the subjacent tissues somewhat contused. It goes by the name of a "brush-burn," and is not unfrequently produced in the manufacturing districts, by the surface of the body coming into contact with straps or portions of machinery in rapid revolution. It has also been known to occur in consequence of a person slipping and gliding rapidly down a long and steep Alpine snow-slope. In this injury the integumental structures are, as it were, ground off, and the areolar and aponeurotic structures converted into an eschar.

The *treatment* presents nothing special, but may be conducted on ordinary principles. The separation of the eschars must be facilitated by water-dressing and poultices; the resulting sores will heal by granulation; and the general health must be supported during the suppurative period that must necessarily ensue.

CHAPTER VIII.

GUNSHOT WOUNDS.

AMONGST the special varieties of contused and lacerated wounds, none are of more interest than the different forms of gunshot injury. Though comparatively and fortunately rare in civil practice in this country, yet they are of sufficiently frequent occurrence to render an acquaintance with them indispensable to the general surgeon. To the military surgeon their study is necessarily one of peculiar interest and importance; and to him I would specially recommend the perusal of the works of Hennen, of Guthrie, of Larrey, and of other surgeons who have had unusual opportunities of studying the nature of these injuries upon the field of battle, and by whom they have been treated with all the minuteness of a specialty. I purpose, in the following observations, chiefly to confine myself to such a general discussion of the subject as is required by the civil practitioner.

Gunshot injuries constitute a species of contused and lacerated wounds, characterized in some cases by the peculiar appearance presented by the color, shape, and size of the orifice; and in others by the extensive injury inflicted on parts, both superficial and deep-seated, in consequence of which the wounds may prove rapidly or are immediately fatal. If the sufferer survive the immediate effects of the injury, high inflammatory action with much pain and tension, with profuse discharge, deep-seated suppuration, and other after-consequences of a serious and very protracted character, are apt to set in. These peculiarities were at different times attributed to the parts being burnt by the ball, to the poisonous nature of projectiles, and to electricity developed by the bullet in its passage through the air, or by its friction against the barrel. All these opinions, however, have been shown to be erroneous; and every peculiarity presented by these injuries can be accounted for by the bluntness of the contusing body, the rapidity of its course, and the force with which it is driven. As John Bell has pithily stated it, "there is a peculiarity, but no mystery, in gunshot wounds." That the sloughing which always occurs in the track of a bullet-wound is due to the injury being inflicted by a blunt body, is evident, from sharp splinters of shell having been known to inflict clean-cut wounds.

Characters.—Gunshot wounds vary greatly according to the nature of the projectile, to the force with which it is driven, and to the direction in which it strikes.

Nature and Force of Projectile.—Gunshot injuries of a serious character may be inflicted by *weapons charged only with powder.* They may arise from the mere concussion of the explosion; thus a pistol charged with powder, and discharged with the muzzle resting against the chest of a man, has been known to kill by concussing the heart. In other cases, a portion of the unexploded powder may be driven into or through the skin by that which is exploded behind it. In this way, very troublesome and disfiguring marks are not unfrequently inflicted on the face, and other parts of the body, by the charcoal of the powder being driven into the skin. That a weapon so charged may actually kill when discharged at a little distance appears from a case related by Dupuytren, in which a fowling-piece charged with powder only, and fired at the distance of two or three feet from the abdomen,

pierced the belly with a round hole and killed the man. The mere force of the explosion will sometimes produce serious lacerations. Suicides occasionally forget to put a bullet into the pistol, and, discharging it into their mouths, blow open the cheeks, and injure the pharynx and glottis by the explosive force. Some years ago, a man was brought to University College Hospital, who had discharged the tube of an *Italian iron*, loaded with powder only, into his mouth, and died in consequence of the injuries he received. In another case in the same Institution, a man died on the fifth day after firing a pistol into his mouth, of asphyxia, occasioned by sloughing of the pharynx and inflammation of the glottis and larynx, consequent on the scorch of the explosion.

Wadding and soft materials, as pieces of clothing, will occasionally inflict serious wounds by the force with which they are driven. These injuries often happen on the stage, at reviews, fairs, &c. Taylor relates several instances of the kind: one of a girl killed by a gun charged with paper pellets; also, one of a man who was killed by a kid glove fired from a blunderbuss.

Small shot often inflict serious injuries, and these are most commonly met with in civil practice. If the person wounded be within a few feet of the muzzle of the gun, a terribly torn and lacerated wound, of a very serious character, even worse than that occasioned by a bullet, will be inflicted; for the shot, not being scattered, are driven through the body in a comparatively compact mass, tearing the tissues to a great extent.

When shots scatter as they fly, they produce at a greater distance a less serious injury, usually lodging in the subcutaneous areolar tissue, where they may remain for years, requiring to be picked out with a lancet; or they may give rise to suppuration. Occasionally shot, by penetrating an important part, may cause serious or fatal results; thus, a single shot penetrating the eyeball will destroy vision; or, lodging in the heart or in the femoral vein, may give rise to rapidly fatal results. A patient was brought to University College Hospital, who had fired a pocket-pistol loaded with small shot into his mouth; after death, the shots were found to have penetrated the anterior portion of the vertebral column, in which they were deeply lodged.

Splinters of various kinds, of shells, of metal, wood, or stone, carried by the force of the explosion, as in blasting and mining operations, inflict perhaps the worst forms of gunshot injury that are met with in civil practice. In siege operations much injury also is often inflicted by the splinters from parapets, or the forcible throwing up of gravel and small stones by the explosion of shells. In naval actions, the force with which splinters of wood are driven, when struck and scattered by cannon-shot, is so great as to inflict the most serious and fatal mischief. A particular form of injury not unfrequently met with in civil practice, and which belongs to this class, is the wound of the eyeball by the explosion and splintering of faulty percussion-caps.

Bullets, *slugs*, and *grape-shot* occasion more serious wounds than any that have yet been described: lacerating soft parts, fracturing and crushing bones, tearing asunder vessels and nerves, perforating the viscera, and occasionally cutting off parts, as a finger, the nose, or an ear.

The general introduction of rifled firearms into modern warfare has greatly increased the destructive effects produced by bullets. The missile is now rarely, if ever, deflected from its course by the resistance offered by bones, tendons, or the elastic reaction of the skin, as happened with the spherical ball; but penetrates in a straight line from the point struck, tearing through the soft parts, and splintering the bones widely. On the bones especially, the modern *conico-cylindrical bullet* produces the most destructive effects; not only comminuting the part struck, but often splitting up the shaft of the bone, by its wedge-like action, in fissures many inches long, leading into contiguous joints. In consequence of this greater and more sudden disorganization of the soft parts, the shock to the nervous system is greater when a person is struck by a conico-cylindrical than by a round ball.

Direction.—In the majority of cases, a bullet traverses, and the wound has two apertures, one of entry, the other of exit; occasionally it happens, however, that in consequence of the ball being spent, or of the piece not having been efficiently loaded, or of the oblique direction with which the ball strikes the part, it merely leaves a contusion or dent, rebounding or glancing off. In other cases there is only one aperture; and here the bullet, partly spent, has probably lodged in the soft

tissues, in a bone, or in the cavity of a hollow organ, as the bladder. It sometimes happens, however, that the ball drops out through the aperture at which it entered, as when a spent ball strikes a rib; or that it carries a pouch of clothing before it, which enables the surgeon to withdraw it. One bullet may even make more than two apertures: thus a ball has been known to split against the sharp edge of the tibia, and to have one aperture of entry and two of exit; or it may pass through both thighs or both calves, and thus occasion four apertures; and cases have been recorded in which five wounds even have been made in the same person by one bullet. Conical balls, as has been already observed, tear their way through the strongest and densest osseous structures.

The direction of the openings is often of importance in a medico-legal as well as in a surgical point of view. Thus, Sir Astley Cooper, by attending to this circumstance in a case of murder, ascertained that the fatal shot must have been fired by a left-handed man; and this led to the detection of the criminal. These apertures, though usually opposite to one another when a ball traverses, will sometimes take a very remarkable course, the bullet being deflected by meeting with obstacles from bones, or by the elasticity of the skin. Thus, a bullet has been known to strike a rib and to be deflected, running under the skin to the opposite side of the body; so again, striking one temple, it has been carried under the scalp to the other side of the head, where it has passed out; thus appearing to have penetrated important cavities which in reality were not wounded.

The *apertures of entry and of exit*, made by a bullet, deserve attentive consideration. Much discussion has arisen as to whether there be any difference between these apertures, and, if so, to what it is owing. That there is a difference in the great majority of cases, there can be no doubt; the hole made by the entrance of the ball being small, depressed, and circular, scarcely admitting the introduction of the little finger (Fig. 58); whilst that made by its exit is a large, somewhat everted, and irregular aperture, into which two or three fingers may be freely passed (Fig. 59). In some cases, however, there is no appreciable difference between the two; and in others, after a time, the aperture of entry is larger than that of exit.

Fig. 58.

Gunshot wound. Aperture of entry.

Fig. 59.

Gunshot wound. Aperture of exit.

There can be no doubt that Mr. Guthrie has given the correct explanation of these discrepancies, when he states, that the amount of the difference in the two apertures will depend partly on the momentum of the ball, and partly on the resistance with which it meets. If the ball strike shortly after its discharge, at the maximum of its velocity, it will make but a small round hole, not so much shattering the parts as separating them. If it traverse a part composed of soft tissue, meeting with but little resistance in its passage, it loses but little of its momentum; and passing out of the body with nearly the same force with which it entered, it makes an aperture of exit that differs but slightly, if at all, from that of entry. If the ball strike a bone on its passage through the limb or body, and thus, by meeting with much resistance, have its momentum materially lessened, the aperture of exit will be torn, large, and ragged, differing materially from that of entry. So also, we find that in all bullet-wounds the entrance-aperture is actually less in diameter than the bullet itself, provided it be made whilst the ball is moving with its full velocity; if it have nearly lost its momentum before it strikes, then the entrance-wound will always be large and ragged. In this there is nothing peculiar to the tissues of the living body; the same happens when any elastic material, as a piece of green timber, is struck. Much, however, will also depend on the period at which the wound is examined. In the early stages, for the reasons mentioned, the wound of entry is smaller than that of exit; but, as the eschar which forms in the

wound of entry is larger than that at the exit-aperture, the former may, in a later stage, appear larger than the latter. This difference in the size of the two wounds I saw well exemplified in the case of a young man, shot through the neck in a duel with a pistol-ball. The aperture of entry, which was at first the smallest, appeared on the second day the largest in consequence of the extrusion of a black eschar; though it continued more regular in shape than that of exit.

[Another reason why the wound of exit is as a rule larger than that of entrance is not mentioned by the author; it is simply that the ball in passing through any portion of the body, carries with it a certain amount of the various tissues with which it meets; hence the mass which inflicts the wound of exit is absolutely larger than that which made the wound of entrance. The same reason is given by Teevan for the larger size of the exit-wound in punctured fractures of the skull.—A.]

Cannon-balls inflict two kinds of injuries. They may contuse a part deeply, crushing muscles and bones, without destroying the integrity of the skin, the ball either having lost its velocity, and being spent, or striking obliquely, or rolling over the surface of the body. The elasticity of the skin preserves this from injury, though all the subjacent textures—bones, muscles, and vessels—may be totally disorganized and crushed into a pulp, if a limb be struck; if the trunk itself be injured, the vertebral column and lumbar muscles may be disorganized, and the liver, kidneys, spleen, stomach, and intestines ruptured without any breach of surface. These injuries, formerly erroneously attributed to the action of the current of air set in motion by the ball, go by the name of *wind-contusions*. In some of these contusions gangrene of the limb sets in; apparently, as Mr. Guthrie has pointed out, from the rupture of the principal vessels.

Cannon-shot more commonly carry away the whole thickness of a part, tearing and shattering a limb, carrying off the thick and fleshy parts of thigh, calf, or shoulder; or they may inflict the most fearful injuries by smashing the trunk and head.

Symptoms.—The chief peculiarities of gunshot injuries consist in the amount and character of the pain, the severity of the shock, the comparatively little liability to hemorrhage, and the severity of the consecutive inflammation.

The *pain* in gunshot injuries varies greatly. It is most severe when a bone is fractured, or a large cavity penetrated; when soft structures alone are injured, a dull and heavy sensation is experienced, which has often been compared to that occasioned by a blow with a stick. In many cases when the mind is actively engaged, as in the height of battle, no pain is experienced, and the sufferer does not know that he is wounded until he is told so, or sees the blood.

In gunshot injuries, the *shock to the nervous system* is always very great where parts of importance, as the head, chest, and abdomen, or large joints, as the knee, are opened; and the severity of the shock is indicative of the amount of mischief inflicted. As has already been stated, the shock is more severe when a wound is inflicted by conical bullets from a rifled musket, than when made by spherical balls from the old smooth bore. Thus, if a bullet appear to have traversed the chest, but in reality has been deflected under the skin, the comparative absence of shock will serve, to a certain extent, to prove that visceral mischief has not been inflicted. In some cases, the shock alone appears sufficient to kill; thus, a man shot by a pistol-bullet, which traversed the distended stomach, died in a few seconds from shock, there being no bleeding of importance, or other discernible cause of immediate death (Taylor). In some cases, however, that are mortal, the symptoms of shock are but slight. It often happens that in the heat of action, a soldier is wounded without being aware of the hurt until he sees or feels the blood trickling. Hennen has known a limb carried off or smashed to pieces by a cannon-shot, without the sufferer being conscious of it; and Macleod relates the case of an officer who, in the Crimea, had both legs carried away, and who was not aware of the injury he had received till he tried to rise.

The *primary hemorrhage* from gunshot wounds varies necessarily according to the situation of the injury and the size of the vessels injured; *cæteris paribus*, they bleed less than other injuries; but in all cases a certain and in many a large and fatal, quantity of blood is lost. When the fleshy parts of a limb are perforated by a bullet, the hemorrhage is usually very trifling, the vessels divided being small, and contused rather than cut across. If the whole of a limb be torn away by a cannon-shot, the arteries of the jagged stump left do not bleed, for the same reasons that those of a limb torn away by machinery do not; viz., the contraction and

retraction of the internal and middle coats, and the twisting of the external cellular coat over the end of the torn vessel. But, though it may be stated as a general rule that gunshot wounds do not bleed much, yet when a large artery, as the carotid, iliac, or femoral, is cut across, violent and suddenly fatal hemorrhage will occur—the vessel bleeding as freely as if divided by the knife. Bullet wounds of the large and deep arteries of the chest and abdomen are almost immediately fatal, from the hemorrhage they occasion. The greater number of those who die in the field of battle perish from this cause. It has often been observed that arteries escape, though lying apparently in the direct track of a ball. In such cases, however, though primary hemorrhage do not occur, the liability to secondary hemorrhage is great.

Gunshot wounds always *inflame*, with much *swelling*, *infiltration*, and *tension* of the parts. The pain which, at the moment of infliction, may not have been severe, becomes extremely acute when inflammation has set in, owing principally to the great tension that takes place. This, indeed, is one of the most remarkable phenomena of gunshot injury, and, by giving rise to strangulation of the tissues, is often the cause of serious mischief. The inflammation speedily terminates in suppuration, often of the most profuse and extensive character, not only in the track of the ball, but widely diffused through the neighboring parts. A period of great danger in gunshot wounds is that about which the sloughs begin to separate, usually from the sixth to the twentieth day; and up to this time it is often impossible to know the precise extent of the disorganization. At this period, also, *consecutive hemorrhage* is very apt to come on, after very slight exertion, without any warning. Baudens states that this occurrence is most likely to happen on the sixth day. This may be suddenly fatal, and is always more dangerous than the primary hemorrhage, not only on account of the difficulty of arresting it, but likewise from the patient being already weakened by inflammatory and suppurative action. Secondary hemorrhage may occur from other causes than the separation of the sloughs and the consequent opening up of an inflamed artery. It may arise from wound of an artery by a spiculum of fractured bone; and from this cause it may arise at any period until all detached bone is separated and the wound firmly cicatrized. Dr. Chisholm, of the Confederate army, mentions a case of death by secondary hemorrhage on the 328th day after a gunshot fracture of the upper third of the thigh, owing to wound of the femoral artery by a detached sequestrum. Independently of this danger from secondary hemorrhage, the patient, if his limb be saved, may have to undergo long and tedious processes of exfoliation of dead bone, and to run the risk of intercurrent attacks of erysipelas, hospital gangrene, and visceral mischief.

Treatment.—Some of the slighter forms of gunshot injuries, those of a purely superficial character, merely require to be treated on the ordinary principles that guide us in the management of contusions and lacerations. When they affect the head, chest, or abdomen, they present so many circumstances of special importance that we must defer their consideration until we treat of injuries of those regions.

In all cases of gunshot wound, whether amputation be ultimately required or not, certain *immediate attentions* are necessary in order to place the sufferer in some degree of comfort and safety. Thus, if a person be shot through the fleshy part of a limb, no bone or vessel of importance being injured, the part should be covered with wet cloths, and placed in an easy position. If there be abundant venous hemorrhage, the limb should be raised; and if this do not arrest the bleeding, a compress should be used. If the hemorrhage be arterial, a tourniquet must be applied. So, also, a tourniquet should be applied if there be rapid dripping of blood, even though the bleeding be not in a jet.

If a limb be smashed, or torn away, a tourniquet should be applied very tightly upon the stump, which must be covered up in wet cloths. The pressure of the tourniquet will not only arrest hemorrhage, but will stay that spasmodic quivering of the muscles of the mangled limb which is so painful to the sufferer.

If the head or neck be wounded, cold wet pledgets should be applied, and hemorrhage, whether venous or arterial, arrested by pressure with the fingers.

If the chest be shot through, the patient should be laid on the injured side, and cold applied. If emphysema occur, or if air freely pass through the wound, a body bandage must be tightly applied.

If the abdomen be wounded, the patient should be laid on the injured side, if the

aperture be a lateral one; if it be central, on his back, with the knees bent over a log or knapsack. If the intestine protrude, it must be washed and quickly returned.

In addition to these immediate attentions, which may be bestowed upon sufferers from gunshot wounds before they are sent to the hospital for more methodical treatment, the influence of the shock should be counteracted by the administration of a little brandy-and-water, and plenty of cold water be given to allay thirst.

Gunshot wounds of the extremities may be divided into two great classes in reference to treatment: 1. Those that do not require amputation. 2. Those in which amputation is necessary.

1. Those cases of gunshot injury that *do not require amputation* must be treated on the principles that guide us in the management of all contused and lacerated wounds; the surgeon, however, bearing in mind that these injuries are especially apt to be followed by extensive and intense inflammatory action, and that sloughing will inevitably result in every part that has been touched by the ball.

The first point to be attended to in these cases is the *arrest of hemorrhage.* In general, this may not give much trouble; but, if a large vessel be injured, the loss of blood will rapidly prove fatal, unless immediately stopped. This is done in the first instance by direct pressure with the fingers on the bleeding part, followed by the application of the tourniquet; or, if this instrument be not at hand, of some simple substitute, such as a pebble, of about the size of an egg, rolled in the middle of a pocket-handkerchief and laid over the artery, the ends of the handkerchief being knotted round the limb, and then twisted up tightly with a piece of stick, or the hilt of a sword passed under it (Fig. 60). The wound in the artery may be of such a kind as to require amputation of the limb; if not, hemorrhage must be permanently arrested by an incision being made down to the bleeding vessel, and a ligature applied on each side of the wound in it, for reasons that will be fully stated when we come to speak of injuries of arteries. In military practice such operations, however, appear to be very rare, and the ligature of a large artery for primary hemorrhage after gunshot injury is scarcely ever practised. The fact is that, if a large artery be wounded, the patient usually dies outright from hemorrhage before anything can be done to arrest the bleeding. If a small vessel only be divided, the hemorrhage will speedily cease of itself.

Fig. 60.

Gunshot wound of thigh: mode of compressing artery temporarily.

The second point to be attended to is the *extraction of foreign bodies*, such as shot, slugs, or bullets, wadding, pieces of clothing that have been carried in with the ball, splinters of bone, and other matters of a like kind. These will generally be found near the aperture of exit, through which they may then be more easily extracted.

If the *bullet* lodge, it, together with foreign bodies accompanying it, such as pieces of clothing, must be extracted through the wound, or cut out by a counter-opening. This second opening is often of great utility in affording a ready exit for discharge, &c. The extraction of the bullet is a matter of great moment. It should be accomplished without delay, before inflammation has set in, and the lips and sides of the wound have become swollen. As Dr. Macleod justly observes, the extraction of the ball not only removes a source of physical irritation and suffering, but of mental disquietude. The mind of the patient becomes more tranquil and easy. Bullets cannot be allowed to remain lodged in the body with impunity. It is true that in some cases they may become encysted, and so cease to irritate; but in the great majority of instances they produce suffering and constitutional disturbance, and may at last occasion fatal mischief; for, although a bullet may continue fixed for years, yet it may at last, under the influence of muscular action, gravity, or the absorption of fat, begin to move and to give rise to injurious consequences. If anything be very tightly fixed, so that it cannot readily be removed,

it must be left till loosened by suppuration. Sometimes a bullet is firmly fixed in the cancellous structure of the articular end of a bone. It may be removed thence by means of an elevator or by the screw-probe. In searching for bullets and other foreign bodies, care should be taken not to probe the wound unnecessarily from mere curiosity, or so as to excite irritation; in many cases, the introduction of the finger is far more useful than that of the probe.

The *splinters* produced by the passage of a ball through a bone are more numerous and larger, when the injury has been inflicted with a conical rifle-ball. The impetus of this projectile is so great, and its wedge-like action so destructive, that the bone struck is shattered into a great multitude of fragments, as well as split longitudinally, often to a great extent. These fragments are detached to a greater or less extent from their connections with the soft parts, and carried out of the axis of the limb. Dupuytren, who was fond of systematizing, has classified splinters of this kind under the three heads of *primary*, *secondary*, and *tertiary*. By *primary* splinters are meant those which are carried completely across the limb, detached from the soft parts, and lodged near the aperture of exit. The *secondary* splinters are those which are still adherent by an edge to a strip of periosteum or to the fibrous tissue; and the *tertiary* are those longitudinal fragments of bone which are not carried out of the axis of the limb. The treatment of these different splinters must necessarily vary. The primary, which are already completely detached, and are insusceptible of consolidation, must be treated as foreign bodies and extracted. The secondary, if very loose, must also be removed; but, if more firmly fixed, they may be pushed into the axis of the injured bone and left. The tertiary must of course be left, and will become consolidated by callus, and so serve in the reconstruction of the bone. Some portions of these, however, will not unfrequently necrose at a later period, and, if engaged and incorporated in a mass of callus, be a very considerable time in separating, keeping sinuses open for years.

Various instruments are used for the detection and removal of bullets and other foreign bodies. There is usually no material difficulty in detecting the presence of a bullet, by means of an ordinary steel probe of sufficient length. In some cases of peculiar and exceptional difficulty, where the bullet is lodged deeply in the cancellous structure of a bone, or amongst swollen and infiltrated tissues, its presence may be detected by the ingenious device adopted by Nelaton in the case of Garibaldi, of passing a probe armed with a piece of unglazed porcelain down to the suspected site of the bullet, and seeing if a streak of lead was left on the rough surface of the china (Fig. 61). For the removal of bullets, long and strong forceps are required, the action of which may be aided by a screw-probe. The accompanying woodcuts (Figs. 62, 63, 64, 65, and 66) represent the best forms of bullet-screws, forceps, and extractors.

In those cases in which small shot are lodged under the skin, they may be turned out by being cut down upon with a fine scalpel.

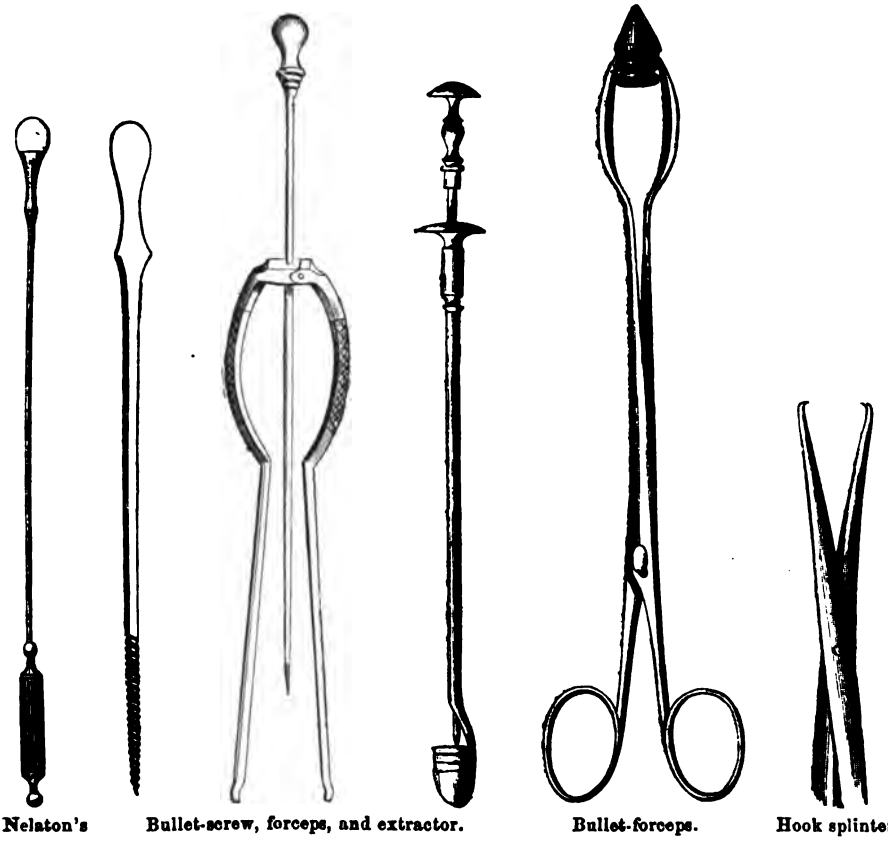
The third point should be the *treatment of the wound* itself, which must be conducted on ordinary surgical principles. This, as has already been stated, will always inflame violently and slough along the whole track of the ball. The principal points to be attended to are, consequently, to limit the inflammation, and to watch and facilitate the separation of the sloughs, and to pay scrupulous attention to cleanliness.

In order to *limit the inflammation*, it was a common practice with military surgeons, and still is so with the French, to dilate by incision the wound made by the ball, with a view of preventing tension and strangulation of parts. [This statement scarcely does justice to French military surgeons, some of the most eminent of whom have strongly reprobated the practice of *débridement*, formerly almost universally adopted.—A.] Since the time, however, when John Hunter pointed out that an incision could not alter the nature of a contused wound, and only superadded another injury to the one already inflicted by the bullet, British surgeons have employed the knife, in the early stages of gunshot wounds, only for the purpose of securing bleeding vessels, or of facilitating the extraction of foreign bodies. In the more advanced stages, however, free incisions, which should be made in the direction of the axis of the limb, are commonly required, in order to lessen inflammatory tension, to prevent the extension of sloughing, and to favor the escape of matter.

The best mode of lessening inflammation in a gunshot wound in the early stages, and more especially in hot climates, is either by cold irrigation or by the application

of dry cold by means of ice in India-rubber bags, conjoined with position and rest; at a later period, water-dressing and poultices will be more useful. As suppuration comes on, we must substitute warm applications for the cold, so as to hasten the

Fig. 61. Fig. 62. Fig. 63. Fig. 64. Fig. 65. Fig. 66.



Nelaton's probe. Bullet-screw, forceps, and extractor. Bullet-forceps. Hook splinter forceps.

formation of matter and the separation of the sloughs. Free incisions may also now be required. These should not be delayed too long. They may be required for two purposes; first, to remove the tension resulting from deep infiltration of the limb by inflammatory effusions, and thus to prevent the strangulation of the tissues, and to remove the severe constitutional reaction that is always consequent to and dependent upon this local inflammatory tension; and secondly, with the view of opening up purulent collections, which often depend upon the irritation of splinters, portions of clothing, and other foreign bodies that could not be removed in the first instance. At the period of the loosening and separation of the sloughs, there is always especial danger of the supervention of consecutive hemorrhage. The patient, consequently, at this time requires to be carefully watched; if the wound be in the vicinity of large vessels, he should have a tourniquet placed loosely round the limb, so as to be screwed up at a moment's notice; and he must, on the supervention of bleeding, have the artery ligatured; if possible, at the seat of the wound; if this be not practicable, in the most convenient situation above it; and if this do not arrest the bleeding, recourse should be had to amputation.

After-consequences of a serious character, such as abscesses, profuse discharges, necrosis, and the separation of splinters of bone, must be looked for in many cases; and these consequences may be prolonged for a considerable series of years, at last perhaps wearing out the patient, if the cause of irritation be not removed. Thus General Bem required to have a bullet removed by Liston from the external con-

dyle of his femur, nineteen years after it first lodged there; and Marshal Moncey died forty years after the receipt of a gunshot wound, from its effects.

A soldier who was wounded at the storming of the Redan, died under my care in the University College Hospital, two years and a half after this event, of exhaustion resulting from a large lumbar abscess. On examination it was found that the bullet, which had entered the left side of the chest and wounded the lung, traversed the diaphragm, notched the spleen, passed between the kidney and suprarenal body, and perforated the spine, was lying encapsuled on the right side of one of the vertebræ, pressing upon the right renal vessels. Its irritation, and that of the sequestra from the injured spine, produced the abscess, from the effect of which the patient died.

2. *Amputation is required* in gunshot injuries in two classes of cases of very dissimilar character.

In cases where the limb has been wholly or in part carried away; where it is evidently hopelessly shattered, the ragged, conical, and quivering stump, or the mangled remains of the limb, must be removed. In such cases there can be no doubt whatever in the mind of any surgeon, as to the necessity for immediate amputation.

But there is another class of cases of a different character, where amputation is also as imperatively required, though to an inexperienced surgeon, or to one accustomed only to the accidents of civil life, it might appear proper to attempt to save the limb. These are, especially, cases of *compound gunshot fractures of the thigh*, *bullet wounds of the knee-joint*, and many similar injuries of the leg. In such cases as these, amputation may not at first appear to be necessary; and similar iujuries arising from other causes, and occurring in civil practice, might admit of an attempt being made to save the limb. But in military practice it is different: here any attempt to save the limb will, to a certainty, be followed by such extreme local and constitutional disturbances as to jeopardize seriously, and probably to destroy the patient's life. In such circumstances, conservatism is a fatal error, and to save life the limb must be sacrificed. The injury for which an experienced army surgeon knows that amputation is imperative, may look but trifling, and to the patient himself, or to the civilian, may appear to admit of treatment by less severe procedure; but experience has incontestably shown that amputation is almost the only hope of safety in gunshot wounds of the lower extremity, fracturing the bones, or injuring the knee-joint. Dupuytren states that, in rejecting amputation in compound fractures of the extremities from gunshot, we lose more lives than we save limbs; and Hennen is of opinion that all "ambiguous cases" should be amputated.

The following is a specification of the chief conditions in which amputation is required: 1. When the whole limb is carried off, a ragged stump merely being left; so, likewise, if the limb be completely crushed and disorganized, whether by direct blow or by a "wind-contusion," though still left adherent; or again, if the principal vessels and soft parts be carried away, though the bone be uninjured, the limb cannot be preserved. 2. Amputation is especially necessary in some of the more serious injuries of the lower extremity; thus, if a bullet divide the femoral vessels, or the sciatic nerve, and splinter the thigh-bone; or if the sciatic nerve and soft parts at the back of the thigh be carried away, although the vessels and bone be left uninjured, the case is one for amputation; and, indeed, it may be stated generally, that all *compound fractures of the lower third of the femur* occasioned by gunshot, require amputation. The mortality, however, after amputation for gunshot injury of the *upper two-thirds of the thigh* is so very great, that many surgeons have abandoned the operation *in these cases*, and professional opinion is unsettled as to the course that should be pursued. In the Schleswig-Holstein war of 1849, it became a question with many of the German and Danish surgeons whether this operation should be continued, or whether the patient would not have a better chance if the injury were treated on ordinary principles as a compound fracture. At the siege of Sebastopol, the mortality after amputation of the upper third of the thigh was so great in the Russian army, that the surgeons abandonded the operation. On the other hand, it is stated in the Report of the Black Sea Fleet, that to attempt to save the limb in any case of gunshot fracture of the thigh was to endanger the patient's life. In the Crimea, Dr. Macleod states, a bad compound fracture of the thigh from gunshot was synonymous with death. This was partly owing to the bad health of the troops, and partly to the terrible effects of conical balls. In

India, where round bullets and matchlock balls are more used, the result is not so bad.

Dr. Macleod states that, although he made every inquiry, he could hear of three cases only in which recovery had, in the Crimea, followed a compound fracture of the upper third of the thigh-bone without amputation. But, exceptional as were such recoveries, he states that they were not so rare as after amputation for similar injuries; as indeed was proved by the fact of not one patient recovering after amputation at the hip-joint. M. Hutin, the surgeon to the Invalides in Paris, was able to discover 24 cases of recovery after compound fracture above the middle of the thigh, but no case of recovery after amputation for injury of the same part. In the British army in the Crimea, the amputations in the upper third of the thigh, which must have been for compound fractures low down in the bone, were fatal, in the ratio of 86 per cent.; of those in the middle, probably for injuries of the lower articular end and knee, 60 per cent. died; whilst of those in the lower third, which must have been for injuries of the knee and leg, the mortality was reduced to 56 per cent. The conclusions at which Dr. Macleod arrives after a careful inquiry into this point, are so important, that I give them in his own words. He says, "Under circumstances of war similar to those which occurred in the East, we ought to try to save compound comminuted fractures of the thigh when situated in the upper third; but immediate amputation should be had recourse to in the case of a like accident occurring in the middle and lower thirds."

3. In gunshot fractures of the *bones of the leg*, amputation becomes necessary if the tibial arteries be injured, or if the knee or ankle-joint be badly wounded. If the injury be in the middle of the leg, at a distance from these joints, and provided there be not longitudinal fissuring of the bone leading into them, much may be done to save the limb, by the extraction of splinters, and the removal of sharp and angular fragments of bone. In such cases, the patient may recover with a shortened but otherwise useful limb.

4. Gunshot wounds of the *foot*, if perforating and splintering the tarsus, require its removal, either at or above the ankle. Those of the *hand* are of special interest from their frequency, in consequence of the bursting of guns, or of powder-flask explosions. In these cases, however extensive the injury may be that is inflicted upon the hand, fingers being blown away, the thumb thrown back, and the metacarpal bones splintered, we must endeavor, if possible, to save a portion of it, if it be only one or two fingers; and, owing to the great reparative power possessed by the hand, we shall often, in the worst looking cases, be able to accomplish this. If the thumb, with one finger as an opponent, can be preserved, it will be of more service to the patient than any artificial contrivance, however ingeniously made. It not unfrequently happens that amputations may be required in the more advanced stages of gunshot injury, in consequence of mortification supervening. In these circumstances, it must be practised without delay, and without waiting for the line of separation. If, in consequence of long-continued suffering and discharge, the patient's health become worn out, and the limb remain an useless appendage, amputation will at last be imperative.

5. Gunshot injuries of *joints* are necessarily of the most serious and fatal character—the danger depending on the size and complexity of the articulation, rather than on the extent of injury inflicted upon it. Wounds of any of the three large joints of the lower extremity are especially dangerous and fatal; those of the upper extremity are more readily, and indeed commonly, recovered from. The fact of a joint being wounded is commonly obvious enough from the direction taken by the ball, the comminution of the bones, and perhaps the escape of synovia; but it must be borne in mind, that a joint may be fatally injured by the longitudinal splitting of the bone into it, although the bullet has not passed within some inches of it.

In bullet-wounds of joints the operation of excision may in many cases be advantageously substituted for amputation. This is the case when the soft parts are not too extensively torn, the large nerves and vessels uninjured, and the shaft of the bone not too widely splintered, the mischief being chiefly confined to the articular ends.

Bullet-wounds of the *head*, *neck*, or *trochanter of the femur*, splintering the bone into the articulation, are necessarily of the most serious character. If they be left

to palliative treatment, the death of the patient may be considered as almost inevitable; if amputation at the hip be performed, the prospect is better; and, though desperate, the case must not be considered as hopeless. This is well illustrated by the result of amputations in the great war of the American rebellion (p. 60). In *Primary* amputations at the hip-joint for gunshot injury, the mortality was, according to one estimate, 94, according to another, and I think more correct, 84 per cent. All *intermediate* amputations were fatal, the *secondary* ones only at the rate of 77 per cent. If the shaft be not too much implicated, it is probable that the best hope lies in the excision of the splintered bone, and the careful removal of the loose fragments. This operation, originally proposed by Mr. Guthrie, and first successfully performed by Mr. O'Leary in the Crimean war, presents the most reasonable, though but a slender, hope of safety to the patient, and should accordingly be practised. With this view the wound must be laid freely open, loose fragments extracted, and the upper end of the bone detached, turned out, and sawn off. Of six cases in which this was done in the Crimea, one patient, Mr. O'Leary's, recovered.

Bullet wounds of the *knee-joint* are amongst the most serious injuries in surgery; and this whether the bones be much comminuted or not, provided the epiphysis of the tibia or femur be perforated, or the articulation be fairly traversed or even penetrated by the ball. Prior to the American war there were but seven cases in which excision of the knee had been done for gunshot injury: five in military, two in civil practice; the two latter cases recovered, the other five died. In the American war the operation was done eleven times: in two cases, one primary, the other secondary, recovery took place; nine deaths resulted, chiefly from pyæmia. In three cases in which the patella alone was excised, death ensued. It would, therefore, appear that if the case be favorable, the soft parts be not much damaged, the large vessels uninjured, the patient young and his health good, excision of the knee for gunshot injury may be a proper procedure; in other circumstances amputation must be done. When amputation is determined on, the operation requires to be performed early, not because the apparent injury may be very severe, or the mutilation of the limb so great as obviously and imperatively to call for immediate amputation, but because experience has shown that, unless the limb be removed at an early period, after-consequences of the most serious and fatal character will to a certainty ensue. Extensive suppuration of the joint, deep and large abscesses burrowing amongst the muscles of the thigh, and consequent exhaustion of the patient by hectic, or his destruction by pyæmia, are the conditions that amputation, performed at an early stage, can alone avert. This necessity for early amputation in penetrating bullet wounds of the knee-joint is recognized by all modern military surgeons. Guthrie and Larrey in the French wars, Esmarch and Stromeyer in the Schleswig-Holstein campaign, and the surgeons in the Crimea, all found that the attempt to save a limb so injured led to the sacrifice of the patient's life.

Bullet wounds of the *ankle-joint* do not necessarily require amputation. If the bones be not too extensively comminuted, and more particularly if the posterior tibial artery and nerve have escaped injury, an attempt, and probably a successful one, may be made to save the limb; the injury being treated on those principles which will be described in the chapters on Fractures and on Dislocations. In such cases extraction of fragments, and excision of the splintered ends, are necessary; and modified operations, partial excision by means of gouge, forceps, and Hey's saw, will be found more successful than the more formal operations. If the large vessels and nerves be cut across, and the bones very extensively shattered, amputation will be the proper course to pursue.

The *shoulder*, from its advanced position, and more particularly the left shoulder in the act of firing, is peculiarly liable to gunshot injury; the bullet either traversing the head of the humerus, lodging in it, or perhaps fracturing some of the bony processes of the scapula in its immediate vicinity; or, as in the case of common shot, or fragments of shells, carrying away the fleshy cushion of the deltoid. It is especially in bullet wounds of the shoulder and elbow-joint that conservative surgery has been attended by the most successful results. In such cases as these, when the bones are penetrated and even shattered by a bullet, provided the main bloodvessels and nerves of the limb be not injured, amputation will seldom be required; and, indeed, it should be laid down as a rule in surgery, that excision should in all cases be preferred to amputation when the large bloodvessels and nerves are not wounded,

or the soft parts too extensively disarranged. The wound being enlarged, loose spicula must be removed, and the splintered and jagged ends of the fractured bone sawn smoothly off. If the bullet be still lodged in the head of the humerus, as in Fig. 67, the same course should be adopted. It has been a question with surgeons, whether excision or amputation should be done in those cases in which the upper end of the shaft of the humerus has been much splintered, with or without penetration of the joint. In these cases the epiphysis is often left uninjured. Guthrie advised amputation in these cases; but the result of the experience of the war in America has been that five or six inches of the shaft of the humerus may be removed with perfect safety, and that no good comes of leaving the uninjured epiphysis, which should therefore also be excised. The results of these excision operations on the joints of the upper extremity are in the highest degree satisfactory. Thus M. Baudens states that he saved 13 out of 14 cases of excision of the shoulder. According to Mr. Thornton, in the British army in the Crimea, the shoulder was excised 12 times with 2 deaths; the elbow in 17 cases, of which 2 were fatal; and partially in 5 other cases, all of which were successful. These results, which reflect the highest credit on the skill of our army surgeons, were more successful than those that followed the amputation of corresponding parts. Of 60 disarticulations at the shoulder, 19, or 31 per cent., were fatal; and of 153 amputations of the arm, 29, or 19 per cent. died. The result of resection of these joints has not been quite so satisfactory elsewhere: thus, in the Confederate army in America, Dr. Chisholm states that, up to February, 1864, of 59 cases of excision of the shoulder 20 proved unsuccessful, and of 45 cases in which the elbow was excised, 9 were unsuccessful. In the official report of the Surgeon-General of the United States army, of 286 cases of excision of the elbow in which the results are known, it is stated that 62 died; and that in 16 amputation became necessary. Of 210 primary excisions of the shoulder-joint death occurred in 50; and in 298 secondary excisions in 115 cases, giving a mean mortality of 32.48, against 39.44 for amputation at the shoulder, and 44.4 for cases treated on the expectant plan.

Fig. 67.

Bullet in head of humerus.

In the Russian army, conservative surgery was also extensively practised; and in it, according to Messrs. Mouat and Wyatt's report, of 20 cases of excision of the elbow, 15 recovered.

Excision of the wrist, in whole or in part, for gunshot injury has not proved very satisfactory, not so much from death as from inutility of the hand that was left. Of 27 done in the American war, 3 deaths only occurred. In two instances amputation of the forearm was practised. But the cases of recovery were not considered satisfactory so far as mobility of the hand was concerned.

The steps of all the excision operations are the same, whether the excision of the part be required for gunshot injury, or for other accidents or for disease; except that in gunshot injury advantage may often be taken of the wound in the soft parts by enlarging which longitudinally the shattered bone may be readily reached and extracted, and the splintered ends sawn smooth.

The question as to the *period at which amputation ought to be performed* after the infliction of these wounds, is one of great importance, and has given rise to a corresponding amount of discussion among surgeons. The older military surgeons, Paré, Wiseman, Ledran, Ranby, &c., taking a common-sense view of the question, advocated the removal of the hopelessly injured limb as soon as possible after the receipt of the injury. Wiseman's advice is to "cut off the limb quickly, while the soldier is heated and in mettle," and this advice has not been and cannot be improved upon. After the battle of Fontenoy, in the middle of the last century, professional opinion underwent a change upon this subject; and Faure wrote a thesis, which obtained the prize of the French Academy of Surgery, recommending delay in amputating in certain cases. Hunter, Percy, and other surgeons of repute, promulgated similar views; until Bilguer, the surgeon-in-chief to the armies of Frederick the Great, went to the absurd and dangerous extent of condemning amputation entirely. These extreme opinions necessarily occasioned a reaction; and the experience gained in the wars of the French Revolution and Empire, has enabled surgeons to settle this question definitely. It is more particularly by the labors and observations of John

Bell, Larrey, Thomson, Guthrie, S. Cooper, and Hennen, that the necessity of having recourse to immediate amputation in all cases of gunshot injury requiring this operation has been fully recognized, and the truth of Wiseman's advice has been re-established.

In determining this point we must be guided, partly by surgical experience on the result of such cases left to nature, and partly by an appeal to facts. In appealing to experience we must, to use the forcible language of Sir Charles Bell, contemplate what will be the condition of the parts in twelve hours, in six days, and in three months. "In twelve hours the inflammation, pain, and tension of the whole limb, the inflamed countenance, the brilliant eye, the sleepless and restless condition, declare the impression the injury is making on the limb and on the constitutional powers. In six days the limb, from the groin to the toe, or from the shoulder to the finger, is swollen to half the size of the body; a violent phlegmonous inflammation pervades the whole; serous effusion has taken place in the whole limb; and abscesses are forming in the great beds of cellular texture throughout the whole extent of the extremity. In three months, if the patient have labored through the agony, the bones are carious; the abscesses are interminable sinuses; the limb is undermined and everywhere unsound; and the constitutional strength ebbs to the lowest degree."

If we appeal to facts, we shall find that of 300 secondary amputations reported by Faure, after the battle of Fontenoy, only 30 were successful; whereas Larrey saved three-fourths of his primary amputations in the Napoleonic wars. In the Peninsular war, the comparative loss after secondary amputations of the upper extremity was, to that following the primary, as twelve to one; and of the lower extremity, the loss after secondary amputation was three times as great as after primary. During the siege of Sebastopol, among 80,000 wounded Russians there were 3000 amputations. Of the primary amputations of the upper extremity, leg, and foot, about one-half, and of the lower and middle third of the thigh, about one-third recovered; but of all the secondary amputations more than two-thirds died. Primary amputation, therefore, should always, when practicable and imperative, be performed in preference to secondary.

But how soon after the infliction of the injury should it be practised? It is the opinion of some surgeons that there is often an interval between the infliction of the injury and the supervention of the shock to the system, in which the limb may more advantageously be removed. Should the depression of "shock" have come on, it then becomes a question whether immediate amputation should be practised, or the removal of the limb delayed until reaction sets in. On this point it is obviously difficult to lay down any very definite rule; but it may, I think, be stated generally as the result of the experience of the best army surgeons, that, if the shock be not very intense, the limb may, under chloroform, be safely removed. Should the prostration be excessive, and there be reason to fear the possibility of internal injury, it will be wiser to delay operation. But if an unsuccessful attempt at the preservation of the limb be made, and if occasion for its subsequent removal should arise, the surgeon must wait until suppuration has set in before he operates, the period of acute inflammatory action being allowed to pass by. The cases that most commonly require secondary amputation are those in which traumatic gangrene has set in; here the limb must always be removed without delay, in accordance with the principles laid down in speaking of this subject in reference to contused wounds. If profuse hemorrhage from the wound occur, that does not admit of suppression by the ordinary means, secondary amputation may become necessary. So, also, when the bones do not unite, the patient being worn out by discharges and the irritation of necrosis and caries, and left with a wasted, shattered, and useless limb, its removal is the only means of saving life. The great mortality after secondary amputation in military practice is, in great measure, doubtless owing to the unfavorable hygienic conditions to which the wounded soldier is usually exposed from overcrowding and want of necessary appliances. He is thus peculiarly liable to the occurrence of pyæmia, sloughing phagedæna, &c.

The nature and treatment of gunshot injuries of special regions, as of the head, chest, and abdomen, will be considered in the chapters devoted to the description of injuries of those parts.

CHAPTER IX.

PUNCTURED AND POISONED WOUNDS.

PUNCTURED WOUNDS.

PUNCTURED wounds, made by narrow sharp-pointed instruments, vary greatly in extent, from the prick of a needle in the finger to a sword-thrust through the body. Not unfrequently punctured wounds are somewhat contused, being made by a triangular or wedge-like weapon, as a bayonet or lance-blade. Hence they partake of the general character of contused wounds, having a tendency to unite by granulation from the bottom, and to be accompanied by much inflammatory action. When deep, they are of a most dangerous character—wounding bloodvessels, traversing the great cavities, and injuring the contained viscera.

Treatment.—In the treatment of punctured wounds, the principal points are to arrest the hemorrhage, and to facilitate union.

The hemorrhage must be arrested by pressure properly applied by means of compressors or pads, so as to approximate the sides of the puncture; by the application of cold; or by cutting down on the injured vessel if it be a large one, and ligaturing it above and below the perforation in it.

In the majority of cases, unless the injury be a slight one, suppuration and union by the second intention will take place. This must be promoted by poulticing; and undue inflammation must be guarded against by local antiphlogistics. In many cases, union by adhesion is obtained; and in others that are allowed to suppurate, there can be little doubt that the same favorable termination might be secured if proper attention were paid to the injury. In former days, when duels with the small-sword were of frequent occurrence, persons called "suckers," who were often the drummers of a regiment, were employed to attend the wounded combatant. Their treatment, which was conducted with a certain degree of mystery, consisted in sucking the wound till all blood ceased to flow, and then applying a pellet of chewed paper or a piece of wet linen to the orifice; in this way it would appear that many sword-thrusts traversing the limbs were healed in a few hours or days. The process of suction cleared the wound thoroughly of all blood, and, drawing the sides into close apposition, placed the parts in the most favorable condition possible for union by adhesion. This practice might, perhaps, in many cases be advantageously imitated in the present day by means of a cupping-glass and syringe.

Amongst the varieties of punctured wounds that are most commonly met with in ordinary practice, are those which are occasioned by needles penetrating into, and breaking off in the body. These accidents chiefly occur in the fingers and feet, and about the nates; and, though of a trivial character, are often extremely troublesome, both to surgeon and patient. When the surgeon is called shortly after the occurrence of the accident, he must endeavor to remove the fragment left behind, by cutting down upon it. In doing this he will be guided by the situation of the puncture, and by the seat of the pain, and sometimes by feeling the point projecting under the skin. In many cases this is a sufficiently simple proceeding; in others, however, a deep and troublesome dissection may be required, especially when the fragment of needle gets into or under the sheaths of a tendon. I have had occasion to undertake somewhat troublesome dissections between the biceps tendon and the brachial artery, or in the close proximity of the ulnar artery, for the removal of fragments of needles lodged in the bend of the arm and the wrist. For the purpose of extracting needles, thorns, splinters of wood, and other foreign bodies of small size and pointed shape lying in narrow wounds, the forceps shown in the annexed wood-cut (Fig. 68)

Fig. 68.

Forceps for removing small pointed bodies.

will be found most serviceable, as they have very fine, but strong and well-serrated points. One of the most dangerous situations for a needle to penetrate is into the anterior part of the knee-joint, lodging on the head of the tibia or the patella, and breaking off short. In such cases the broken fragment should be dissected out at once, the limb put on a splint, and the ice-bag applied, so as to restrain inflammation of the joint. I have known the most disastrous and disorganizing inflammation and suppuration of the knee-joint ensue, with imminent peril to life, and followed by anchylosis in consequence of a portion of needle having been allowed to remain imbedded for some days before extraction.

In many cases, if the needle have been lodged for some days, the surgeon will fail in his endeavors to extract it; and, unless the indications of its presence be very clear, I think the wiser course is to leave it undisturbed, and to trust to nature for its elimination from the body, as it will seldom be found when sought for, and, indeed, may not exist, although supposed to be present. The following plan of ascertaining whether a portion of needle be really impacted has been suggested by Mr. Marshall. A powerful magnet is to be held upon the part for a quarter of an hour, so as to influence the fragment; a finely-hung polarized needle should then be suspended over it, when, if any iron be present, deflection will ensue.

POISONED WOUNDS.

A very important variety of punctured wound is that in which a poison is introduced into the puncture. The most important of these poisoned wounds are those inflicted by the stings of insects, the bites of snakes or of rabid animals, and injuries received in dissection.

Stings of Insects, as of bees, wasps, mosquitoes, gnats, &c., though painful, seldom produce any serious inconvenience; yet occasionally they may do so, and even prove fatal, by inducing erysipelas in some unhealthy constitutions, or by giving rise to intense irritation from the multiplicity of the stings, as when bees swarm upon and sting a person in great numbers; or they may be dangerous in consequence of an important part being stung, as the eye, or the interior of the mouth, or pharynx, as has happened from swallowing a bee in a piece of honeycomb. Mosquito bites are peculiarly irritating, and when numerous poison the blood, producing nervous depression and great febrile irritation. Some insects, as scorpions, or the tarantula in Italy, give rise to more serious and even fatal disturbance by their bite. A peculiar train of nervous phenomena is said to follow the bite of the tarantula, hence called "tarantismus;" a disease that is generally stated to be peculiarly influenced by music, though this has been denied by M. Gozzo.

Treatment.—In the treatment of stings of insects the application of cooling lotions, of a cold poultice, or rubbing the part with olive oil, will be found the most useful means of allaying irritation. In some cases, more especially in mosquito bites, touching the part stung with strong liquor ammoniæ gives immediate relief.

Snake-bites are seldom fatal in England; venomous reptiles, such as the viper and adder, not possessing a sufficiently energetic poison to destroy a healthy adult, though they might possibly kill a child or a very delicate and weakly person. They are said to be most active in warm weather and during the season of procreation, and their bites are most dangerous if inflicted through a vein or glandular part, or near the centre of the circulation, or about the neck and face. In tropical countries the bite of the rattlesnake, of the cobra di capello, the puff-adder, or the tobacco-pipe snake, is often fatal; and it occasionally happens even in this country, that the surgeon has an opportunity of seeing wounds inflicted by these fearful reptiles in menageries. Thus, Sir E. Home has recorded a fatal case of rattlesnake bite occurring in England. A similar instance has occurred at St. George's Hospital, and another in Paris, to showmen. The most remarkable case of this kind with which I am acquainted occurred some years ago at the University College Hospital, affording an opportunity, rare in this country, of witnessing the effects of the bite of a cobra di capello. The patient, a keeper at the Zoological Gardens, was bitten in the bridge of the nose, the poison-fang having apparently penetrated the angular vein. When brought to the hospital, about half an hour after the accident, he was apparently dying, being unable to speak, swallow, or support himself; the pupils were dilated, the face livid, the heart's action feeble, and he was scarcely conscious. After death, which took place in little more than an hour from the time of the

infliction of the wound, the veins of the brain and the cerebral sinuses were found congested with blood, as were also the lungs to an immense extent, and the solid abdominal viscera. The right cavities of the heart were loaded with dark blood, the left being empty; indeed, the phenomena of asphyxia were strikingly marked. In this case, death would appear to have resulted from the poison paralyzing the medulla oblongata, and those portions of the nervous system which are instrumental in carrying on respiration, at the same time that the blood was disorganized by the action of the virus.

Effects of Snake-Poison.—Snake-poison, when introduced into the system, may prove injurious or kill in two ways: either by its primary and direct depressing influence on the nervous system, somewhat resembling that produced by some narcotic poisons; or, secondarily and more remotely, by exciting severe diffuse inflammation of the areolar tissue of the limb or part.

The first mode of death occurs only when the poison is either very powerful, or the animal bitten small. Thus the poison of the tobacco-pipe snake is said to be so virulent, that it will kill a full-grown man in less than a quarter of an hour. The rattlesnake, and the cobra di capello, will kill a small animal in the course of a few seconds; and a man, bitten some years ago by a rattlesnake in Paris, died in nine hours; the cobra bite just related was fatal in less than one hour.

[Dr. E. B. Shapleigh has lately reported to the College of Physicians of Philadelphia, a case of rattlesnake poisoning, where death followed forty minutes after the infliction of the bite. (*Amer. Journ. of Med. Sciences* for April, 1869.)—A.]

In other cases, again, the poison acts by exciting diffuse inflammation, suppuration, &c., of the areolar tissue. Thus, in the case which occurred in St. George's Hospital, the patient died on the eighteenth day after the bite of a rattlesnake, with large abscesses in the arm and in the axilla, and with sloughing of the areolar tissue of the limb.

The *symptoms* occurring after a poisonous snake-bite consist in great depression and prostration of the system, a feeble and intermittent pulse, dilated pupils, usually slight delirium, speedy stupor, insensibility, and death. The part bitten swells and becomes livid in a few hours; and if the patient survive sufficiently long, diffuse inflammation and gangrene occur in its neighborhood; involuntary evacuations take place; asthenic symptoms set in, which may eventually terminate fatally in the way that has already been mentioned, or end slowly, and after a lapse of time, in the recovery of the patient, whose health may long suffer seriously from the effects of the accident.

The *treatment* of these injuries is local and general.

The *local treatment* presents two great indications: 1, to prevent the absorption of the poison into the system; and 2, to treat the diffuse inflammation and sloughing that may subsequently occur. The first indication may be fulfilled by tying a ligature so tightly round the limb at a little distance above the injured part, as to arrest all circulation through it. In this way the absorption of the poison may be prevented; the wound should then be freely cauterized with a red-hot iron or cinder, or, better still, be excised, and a cupping-glass applied over the cut surface, so as to withdraw the blood in the neighborhood which may have become contaminated by the poison. If a cupping-glass be not at hand, or if the part bitten be so situated as not to admit of its application, there can be no objection to the employment of suction by the mouth after free excision; the poison not being absorbed by an unbroken mucous membrane. In using suction, the mouth should be rinsed with brandy. With the view of lessening the swelling, tension, and pain of the limb, frictions with olive oil are said to be advantageous. After diffuse inflammation has set in, this must be treated on general principles—by fomentations and free incision.

[Dr. S. Weir Mitchell, of this city, one of the highest living authorities on all subjects connected with the bite of the rattlesnake, strongly recommends what he calls the *intermittent ligature*. This is applied by means of a tourniquet, which is occasionally slightly relaxed, and again quickly tightened; small quantities of venom may, in this way, be admitted from time to time into the general circulation, and the enemy, thus fought, as it were, by detachments, may be met with more hope of success than without this precaution. (*Researches upon the Venom of the Rattlesnake, Smithsonian Contribution*, Jan. 1861, p. 110.)—A.]

The *constitutional treatment* consists in the early and free administration of the

most powerful stimulants, with the view of combating the depression that exists. For this purpose, brandy, wine, ammonia, or ether must be freely given. The *eau de luce*—which enjoys a high reputation in some tropical countries—owes its efficacy to the ammonia which it contains. Should drowsiness come on, the patient must be walked about; and artificial respiration with galvanism may be resorted to as a last means of maintaining life, until the effects of the stimulants may overcome those of the poison. Large doses of arsenic have been recommended as a kind of specific, and the "Tanjore pill," a celebrated Indian remedy, owes its activity to this mineral; but care must, of course, be taken in administering this, lest the remedy prove as fatal as the injury for which it is administered.

[The following is the formula for what is known as "Bibron's antidote," which was some years ago highly recommended by Dr. Wm. A. Hammond of New York as a remedy in cases of rattlesnake poisoning: "℞. Potassii iodidi, gr. iv; Hydrargyri chloridi corrosivi, gr. ij; Brominii, f℥v.—Misce." Ten drops of this mixture are directed to be given in wine or brandy every hour, or half hour, as required. *A priori* this would seem to be a combination which should prove serviceable, the bromine and corrosive sublimate being powerful antiseptics and coagulants, while the iodide of potassium would carry out the depurative plan which was recommended in cases of snake-bite by Celsus. Dr. Mitchell's experiments on the lower animals have not, however, tended to confirm the expectations entertained as to the utility of the antidote, and it would seem that the constitutional treatment most to be relied on is that recommended by the author, free stimulation, of course not urged to the production of intoxication.—A.]

Bites of Rabid Animals give rise to the disease so much and so justly dreaded, but fortunately so seldom seen in man in this country, termed *hydrophobia*.

This disease cannot originate *de novo* in man, but invariably occurs in him, and most commonly in the lower animals, as the result of contagion. Animals of the canine and feline species are most subject to it; especially the dog, the wolf, the fox, the jackal, and the cat. It has not, I believe, been observed in lions or tigers, or the larger feline animals. When originating *de novo* in animals, its causes are excessively obscure. It has been attributed to the influence of season; thus Eckel finds it most common in dogs in the months of February and May; but want of water, sudden changes from heat to cold, bad food, and unsatisfied sexual desires, have all been assigned as causes of its occurrence in animals. When we inquire into the operation of these various causes, we fail to discover any direct and positive connection between any one of them and rabies. With regard to the influence of want of water and heat in disposing to or in occasioning the disease, it would appear that in those countries in which animals of the canine and feline races are most exposed to these conditions hydrophobia is unknown. Thus Mr. Donovan, who has resided and travelled for many years in Central Africa, informs me that, in the deserts of that country, where water is so scarce that man and beast often die of thirst, lions are always to be found, and are occasionally seen going about in families, whilst hyenas, jackals, and wild dogs are most numerous, and yet hydrophobia is unknown. Barrow, a scientific and observant traveller, makes a similar statement, viz., that hydrophobia cannot proceed from thirst and heat, as it is unknown in Egypt, the West India Islands, and some other tropical parts. The theory of hydrophobia arising from ungratified sexual desire appears to be equally untenable. It is not uncommon in Africa, Mr. Donovan says, for wolves, jackals, and wild dogs to prowl about mad with heat; and in this state they are most dangerous, so much so that domesticated dogs instinctively shun them, but there is no evidence of their ever having communicated hydrophobia. Having been told that no bitches were allowed in Sark, I wrote to Dr. Cockridge of that Island to inquire if this were the fact, and if so, whether hydrophobia was prevalent there. He informed me that there were no bitches in the island, and that dogs were very numerous, but that no case of hydrophobia had, to his knowledge, ever occurred there, and that the clergyman, who had had thirty years' experience of the island, had never heard of a case of that disease. Dogs more frequently become rabid than bitches; thus, of a hundred and forty-one cases collected by Eckel, only fifteen occurred in bitches; and amongst dogs it is most common in those of a mongrel breed, seldom affecting those that are of pure blood, or that have been castrated. In the human subject it never appears except as the result of contagion either by a bite, or by the rabid animal licking a raw surface, as an abrasion on the hand or

lip. The bite of a rabid animal is most dangerous when inflicted on a naked part, as on the hand or face. A person bitten through clothing often escapes any ill effects, in consequence of the teeth being wiped and the poisonous saliva arrested by the clothes. Hence a number of persons may be bitten by the same rabid animal, and but a very few take the disease; not more, perhaps, than one in ten or twenty. Hydrophobia may occur by the inoculation of a wound, and not by a bite only. Thus it has been known to be developed by a lap-dog licking the lip of a lady, on which there was a crack.

The period that intervenes between the bite and the occurrence of the disease is usually considerable. Meade has related the case of a lady who had the disease fifteen months after the bite. Elliotson says that the average time that elapses between the injury and the symptoms is from six weeks to three months. In the case of the Duke of Richmond, who was bitten by a tame fox, the disease did not develop itself until between six and seven weeks after the injury. Writers, however, in stating that six, seven, twelve, and even fifteen years have intervened between the infliction of the wound and the manifestation of the symptoms, have evidently committed an exaggeration or fallen into error, having very probably confounded with hydrophobia other nervous affections that closely resemble it.

Symptoms.—The wound has generally cicatrized long before any symptoms of hydrophobia declare themselves; and no peculiar appearance is presented by the scar. Shooting pains, twitching and itching sensations have, however, occasionally been experienced in the site of the wound before the supervention of the attack; and it is probable that in all cases some process analogous to a zymotic action takes place within it before the disease comes on. The precise nature of this, however, requires to be elucidated by further observation.

The *general* symptoms are usually ushered in by some antecedent phenomena for two or three days; according to Perry for five or six. These initiatory symptoms consist of giddiness, chills, and heats, and a general feeling of discomfort. The more *special* symptoms never manifest themselves until the disease becomes fairly established; they consist essentially in violent and repeated convulsive movements of a reflex character, induced by various external influences, whether acting on the surface of the body or on the fauces, or by mental impressions; and they speedily end in exhaustion and death. The special symptoms may be arranged under three heads: consisting, of 1. Spasmodic affection of the muscles of deglutition and respiration; 2. Extreme sensibility of the surface and of the senses; and 3. Excessive mental terror and agitation.

1. In consequence of the *spasmodic affection of the muscles of deglutition*, the act of swallowing commonly excites convulsions; hence the patient experiences a horror of all liquids; and, in attempting to drink, gulps down the fluid with a strong mental effort. In some cases, solids give rise to the same difficulty in deglutition as liquids; but occasionally, though rarely, patients have been known to swallow perfectly well throughout the disease. This difficulty in swallowing is certainly owing to an excessive sensibility about the pharynx and throat, in consequence of which every effort at deglutition induces violent reflex convulsive movements.

A catch in the breathing, resembling what often occurs when a person goes into a cold bath, is met with as one of the earlier symptoms, taking place in the midst of conversation, and before the patient's mind is directed to the nature of the disease. This catch is due to the spasmodic descent of the diaphragm, and gives rise to severe pain at the pit of the stomach, or to a feeling of suffocation, and a return of the convulsions. In consequence of this spasm of the diaphragm, the patient makes from time to time a loud hiccuping noise, which has been likened to the bark of a dog.

2. An extreme degree of *sensibility of the surface, and of some of the senses*, is characteristic of hydrophobia. The cutaneous nerves become so sensitive that a blast of cold air, the rustling of the bedclothes, the slightest touch of or movement on the skin, will bring on convulsions. The nerves of sense become equally excitable, so that a sudden flash of light before the eyes, as the reflection of the sun from a looking glass, or a sudden noise, as the slamming of a door, will produce the same effect. The noise produced by liquids being poured from one vessel to another is peculiarly distressing to the patient; and Dr. Elliotson mentions a patient with

hydrophobia being thrown into violent agitation by hearing the dresser, who sat up with him, make water.

The sufferings and convulsions that patients experience when they attempt to drink, appear to be owing to this excessive sensibility of the nerves of the mouth and pharynx, and the recollection of these sufferings makes them afraid to repeat the attempt; hence the fear of liquids from which the disease derives its name.

3. One of the earliest symptoms of hydrophobia, and one of the most persistent, is an extreme degree of *mental agitation and terror*, a vague sense of dread and horror at the impending fate. Delusion of a spectral character sometimes occurs, the patient supposing himself to be surrounded by animals, by horrid forms, or by gaping, ghastly, and grinning countenances. The first symptom in the Duke of Richmond's case was, that he fancied some poplar trees opposite his bedroom window to be men looking in. These delusions may alternate with fits of delirium and frenzy. In these it is said that the patient barks like a dog, and endeavors to bite; but this is a popular error—the pretended bark is merely the catch in breathing, and the attempt to bite is nothing but movements of the tongue and mouth induced by the clamminess of the viscid and ropy mucous saliva. Occasionally the symptoms subside completely before death; the sensibility of the surface disappearing, the mental agitation or delusion being removed, and deglutition and respiration being quietly performed. Thus Dr. Latham relates the case of a man laboring under this disease, who sat up quietly in bed and drank a pint of porter half an hour before he died.

Prognosis.—I am not acquainted with any authentic case of recovery from hydrophobia, after the disease has fairly set in. The disease may prove fatal in four-and-twenty hours, or life may be prolonged for six or seven days; death generally occurring from the second to the fourth day, and being apparently induced by exhaustion.

Pathology.—The appearances found after death throw no light whatever upon the disease, and indeed may often be supposed to be the effects rather than the causes of the spasmodic irritation. The tongue, the fauces, the throat, the glottis, and the larynx, the stomach and œsophagus, the brain, the medulla oblongata, and spinal cord, have all been found congested and inflamed; there is nothing, however, in the appearances presented by these parts that affords a clue to the true nature of this inscrutable and terrible malady. In fact, everything connected with hydrophobia is at present involved in complete obscurity. We neither know what occasions rabies in the dog, nor in what the change in his secretions consists, that enables him to transmit the disease to man. Equally obscure are the processes that are going on at the seat of the wound or in the constitution generally, during that lengthened period that intervenes between the infliction of the bite and the development of the disease; and lastly, pathological research has hitherto failed to throw the faintest glimmer of light on the nature of the changes which the nervous system undergoes, and which occasion the characteristic phenomena of hydrophobia.

Treatment.—This must principally be of a *preventive* and *palliative* character. We cannot speak of *curative* treatment of hydrophobia; for, after the disease has once set in, the utmost that can be done will not accomplish more than to lessen the sufferings of the patient, and stay for a few hours the inevitably fatal termination.

When a person is bitten by a dog that is mad, or even by one that is supposed to be so, the surgeon should always adopt energetic means to save the patient from the invasion of a disease that is necessarily fatal. In having recourse to preventive treatment, it should be borne in mind that the larger proportion of persons actually bitten by rabid animals do not fall victims to hydrophobia; the probability of the occurrence of the disease depending partly upon the animal that bites, and partly upon whether the bite is inflicted on the naked or on the clothed part of the body. Thus Watson states that, of 114 persons bitten by mad wolves, 67 died of hydrophobia; whilst, according to Hunter and Vaughan, one out of 20 or 30 bitten by mad dogs take the disease. This latter estimate may possibly be somewhat lower than the truth; yet the fact remains certain that wolf-bites are far more dangerous than dog-bites, and this probably owing to the circumstance of wolves always flying at the face and naked parts. It is in consequence of this small proportion of persons taking the disease out of the total number bitten, that so many popular remedies and superstitions have obtained an unmerited reputation for preventing

the disease. The only preventive means that can be trusted to by a surgeon, are *excision* and *caustic*.

Excision of the part bitten should be carefully and freely performed, no half measures being had recourse to. Hence it is better to remove too much of a comparatively unimportant tissue or part, than to allow the sufferer to run any risk of falling a victim to the fatal disease. In order to excise every part that has been touched by the tooth, the surgeon, after washing the wound and contiguous surface, should make a circle with ink, or tincture of iodine, completely round the injured part. He must then pass a probe to the bottom of the wound, and excise the whole by scooping out a conical piece of the tissues, taking care to go beyond the furthest limit to which the probe is passed. If there be any doubt of the whole of the injured parts having been removed, potassa fusa should be applied. If the lip be bitten through, a portion should be cut out, and the wound brought together, as in hare-lip operations; if it be a finger that is injured, amputation of it should be performed. In those cases in which the wound is so situated that excision cannot readily be performed, potassa fusa, or strong nitric acid, or nitrate of silver, as recommended by Mr. Youatt, should be freely applied to every corner of it.

If the bite have already cicatrized, the place should be excised at any time after the injury, provided the dog is known to have been, or to have become mad; for it is not improbable that the occurrence of some of the remoter cases of the disease is dependent upon, or connected with, some peculiar action set up in the wound, which might possibly be averted by the removal of the cicatrix.

I forbear to speak of any other means of preventive treatment, as I consider them utterly undeserving of confidence.

After the disease has once set in, nothing can be done but to *palliate symptoms* and to prolong life. Every possible remedy that the ingenuity of man could devise, from warm water to viper and ticuna poison, has been tried, and found utterly useless. The only plan of treatment that holds out a hope of eventual success, and which, whether it succeed or not in curing the patient, at all events mitigates his sufferings, is that which has been recommended by Drs. Marshall Hall and Todd. It consists, in the first place, in removing all external irritation, whether mental or bodily; putting the patient in a darkened room, as much removed as possible from all noise and the intrusive curiosity of strangers, and surrounding his bed with gauze curtains or screens, so as to prevent the disturbing influence even of a draught of cold air. Measures must then be adopted to lessen the excitability of the spinal cord: this may be done most efficiently, as Dr. Todd suggests, by the application of ice in a piece of gut laid along the whole length of the spine. [The best means of applying cold to the spine is by the use of what are known as "Dr. Chapman's ice bags."—A.] Lastly, the surgeon must bear in mind that he has to treat an exhausting disease, and that he must consequently support the patient by wine, beef-tea, and such nourishment as can be taken.

Wounds with Inoculation of Decomposing Animal Matter.—The majority of wounds of this character are not dangerous. Every student of anatomy frequently punctures and cuts himself in dissecting, and it is but rarely that we see any ill consequences following these injuries. In some cases, however, the most serious results, terminating in permanently impaired health, or even in death, ensue. The result depends fully as much on the state of health of the person punctured, as on the condition of the body from which the puncture is received. If the health be broken by any cause, whether excess of study or dissipation, very serious effects may follow, which would not occur if the patient had the resisting power of a sound and strong constitution; hence it is of much importance to those engaged in the practical study of anatomy, not to allow the health to become impaired to too great an extent.

Causes.—The deleterious influence exercised by the dead body, human or brute, may be attributed to three different causes: 1. The mere ordinary irritation of the wound; 2. Inoculation of putrid matter; or 3. Introduction of a specific virus into the system. I think it is probable that each of these causes may exercise an influence, but that the worst effects of dissection wounds are dependent on the inoculation of a peculiar and specific virus.

1. That ill effects sometimes result from the simple *irritation of the puncture*, is evident from the fact that we see mere scratches or punctures with splinters of wood, or other harmless substances, give rise to considerable local disturbance in

certain states of the constitution; so also we find that those dissection wounds which are ragged and torn, such as are made by spicula of bone or the teeth of a saw, are attended by peculiarly troublesome consequences.

2. *Putrescent matters* must always be injurious when introduced into the economy; but at the same time it is a remarkable fact, that the worst dissection wounds have been received before putrefaction had set in, and that they more commonly occur in *post-mortem* inspections made a few hours after death, than in dissecting-room investigations on parts in an advanced stage of decomposition.

3. That the worst forms of dissection wounds are dependent upon a *specific virus*, is evident from the fact that it is especially after death from certain inflammatory diseases, especially of an erysipelatous type, that these consequences ensue. Most danger is to be apprehended from punctures received from the bodies of those who die of erysipelas, phlebitis, and the diffuse forms of peritonitis following parturition or the operation for hernia. And it is very important to observe that putrefaction is by no means necessary for this. Indeed, the greatest danger exists before putrefaction sets in. A few hours after death, whilst still quite fresh, the body is in the highest degree infectious and dangerous; and in these cases I think that advanced putrefaction rather lessens than increases the danger. Of all these influences, that which is generated by tumor or puerperal peritonitis is by far the most noxious. The acrid fluid which accumulates in the peritoneum when that structure is attacked by diffuse inflammation of the kind just mentioned appears to exercise a specifically injurious influence. I believe it to be impossible to immerse the hand into it with impunity if there should happen to be a scratch, puncture, or abraded surface of any kind on one of the fingers. Inoculation would, under such circumstances, inevitably ensue, followed by diffuse inflammation to a greater or less extent. That the poisonous influence from the bodies of persons who have died of these diseases is transmissible to others by contact or infection, cannot be denied; and accoucheurs and operating surgeons should abstain as carefully as possible from performing *post-mortem* examinations on patients dying from such diseases, lest the poisonous influence be carried to and excite similar morbid action in their own patients. The mere contact of such a body, independently of any wound, is occasionally dangerous. Thus, I have known a body seriously infect in different ways six students who were working at it. Two had suppuration of the areolar tissues, under the pectorals and in the axilla; one was seized with a kind of maniacal delirium; the fourth had typhoid fever; and the remaining two were seriously, though not dangerously, indisposed.

Symptoms.—From what has been stated above, it would appear that there are two distinct kinds of mischief resulting from dissection-wounds.

The *milder form* is not specific, but proceeds from the simple irritation of a scratch in a broken constitution, or from the inoculation of putrescent matter. In these cases the part punctured becomes painful, hot, and throbbing, in from twelve to twenty-four hours after the injury; the finger swells and inflames, the absorbents of the arm are perhaps affected, and the glands in the axilla become enlarged. There is general febrile disturbance of an inflammatory character, ushered in by rigors and a feeling of depression; suppuration takes place about the puncture, and also, perhaps, in the inflamed glands, the case presenting the ordinary characters of whitlow with inflammation of the absorbents.

In the *more severe form* of dissection-wound, the patient is seized, about twelve or eighteen hours after the puncture, with rigors, anxiety of countenance, and depression of the nervous system; with a quick pulse, and with inflammatory febrile reaction. On examining the finger, a pustule, or vesicle, with an inflamed areola, will be observed in the situation of the puncture; from this a few red lines may be seen stretching up towards the armpit, where there may be swelling and tension. Diffuse inflammation of the areolar tissue of the limb sets in about the fifth or sixth day, extending up to the shoulder, and down the side of the chest to the flank. Abscesses form, often with much pain, in these situations; they are usually somewhat diffuse, the pus being mixed with shreds and sloughs. The general symptoms gradually assume an asthenic type; the tongue becomes brown, sordes accumulate about the lips and gums, low delirium sets in with a rapid feeble pulse, and death occurs in from ten days to three weeks. When incisions are made into the brawny tissue, it is found infiltrated with sero-pus, and in a sloughy state. If the patient live, large circumscribed abscesses form under the pectorals, in the axilla, and above

the clavicle, with much exhaustion and depression of the system, convalescence being tedious and prolonged, and the constitution often shattered for life.

It is this form of the disease that resembles diffuse inflammation of the areolar tissue arising from other causes; and indeed there can be little doubt that it is a cellular erysipelas dependent on a toxic agency. That this form of dissection-wound is of a truly erysipelatous character, is evident from the fact that patients laboring under it will communicate fatal erysipelas to their nurses and attendants; as happened in the case of the late Mr. J. P. Potter, of University College Hospital, whose early death was much to be lamented. It is also this kind of dissection-wound that is especially apt to occur after punctures, received from patients who have died of diffuse inflammation of the serous membranes.

Treatment.—On the receipt of a puncture in dissection, the best mode to prevent injurious consequences, is to tie a string tightly round the finger above the injury, thus causing the blood to flow, and perhaps to wash out the virus with it. The part should then be well washed in a stream of cold water at a tap, and sucked for some minutes; in this way any poisonous matter that has been introduced may usually be got rid of. I think that, in general, it is better not to apply caustics in these cases; they only irritate and inflame the finger, and can do but little good. If any caustic be employed, it should be a drop of nitric acid let fall into the wound. The nitrate of silver, which is commonly employed, can never do much good, as it does not penetrate to a sufficient depth to be of service. Dissectors should bear in mind that the state of the constitution exercises great influence upon the effects of the puncture; and that, in proportion as the health is sound, there is less likelihood of any injurious consequences ensuing.

In the slighter forms of dissection-wound, attended by a moderate amount of inflammation, the part must be poulticed, leeches should be applied, and the arm put in a sling. If the absorbents become inflamed, chamomile and poppy fomentations must be diligently used, abscesses must be opened early, and free incisions should be made wherever there is much tension, even though matter have not already formed, with a view to prevent suppuration. The general treatment of clearing out the bowels with a free calomel purge, followed by moderate antiphlogistics, must be followed in the early stage; but support will soon be required, and, if there be much constitutional irritation, opiates may advantageously be administered.

The treatment of the more severe forms of dissection-injury consists principally in fomentations, and in early and very free incisions into the finger or other parts that become tense and brawny. In the constitutional treatment our great reliance, after clearing out the intestinal canal by a free purge, such as five grains of calomel and fifteen grains of jalap, consists in the administration of bark, ammonia, camphor, wine, and brandy, with such nourishment as the patient can take; the case being treated as one of the lowest forms of asthenic inflammation. If the patient survive, he must be sent as soon as possible into the country, and must devote some months, perhaps, to the re-establishment of his health. The part that has been punctured often continues irritable for a great length of time, even for many years, remaining red, inflamed, and desquamating, with perhaps the occasional formation of pustules on it. This condition is best remedied by the occasional application of nitrate of silver.

CHAPTER X.

EFFECTS OF HEAT AND COLD.

BURNS AND SCALDS.

A *burn* is the result of the application of so great a degree of heat to the body as to produce either inflammation of the part to which it is applied, or charring and complete disorganization of its tissue. A *scald* is occasioned by the application of some hot fluid to the body, giving rise to the same destructive effects as are met with in burns, though differing from them in the appearances produced.

Local Effects.—Burns and scalds vary greatly in the degree of disorganization of tissue to which they give rise; this variation depending partly upon the intensity of the heat, and partly upon the duration of its application. The sudden and brief application of flame to the surface produces but very slight disorganization of the cuticle, with some inflammation of the skin. If the part be exposed for a longer time to the action of the flame, as when a woman's clothes take fire, the cutis itself may be disorganized; and, if the heat be still more intense, as when molten metal falls upon the body, the soft parts may be deeply charred, or the whole thickness of a limb destroyed. So, also, the effects of scalds vary greatly, not only according to the temperature of the liquid, but according to its character; the more oleaginous and thick the fluid, the more severe usually will the scald be.

These various results of the application of heat to the surface have been arranged by Dupuytren into six different degrees of burn. In the *first*, there is merely a scorch of the skin, slight redness with efflorescence of the cuticle, but no permanent injury. In the *second* degree, there is not only general redness of the part to which the heat has been applied, but vesicles form, either at once or in the course of a few hours, and sometimes attain a very considerable magnitude. In the *third* degree, the cutis itself is destroyed; yellowish-gray or brownish eschars form, and involve the whole thickness of the skin; and the surrounding integument is more or less reddened and vesicated, and the part extremely painful. If this amount of injury be the result of a scald, the eschars will be soft, pulpy, and of an ashy-gray color. In the *fourth* degree, the whole thickness of the skin and part of the subcutaneous areolar tissue are destroyed; dry, yellowish-black, insensible eschars being formed, with considerable inflammation around them, leaving on their separation deep and luxuriantly granulating ulcerated surfaces. In the *fifth* degree, the eschars extend more deeply, implicating the muscles, fasciæ, and soft structures. And, in the *sixth* degree, the whole thickness of the limb is completely destroyed and charred. This is the celebrated classification introduced by Dupuytren, and adopted by most writers on the subject as a practical exposition of the local effects of burns. These various degrees are usually found associated to a greater or less extent; indeed, in the more severe cases, the first three or four degrees are almost invariably met with together.

The primary *local effect*, then, of a burn, if superficial, is to excite inflammation of the skin; if more extensive, to destroy the vitality of more or less of the soft structures, and even the bones. When the cuticle is unbroken, the inflammation speedily subsides with some desquamation. When the soft parts are charred, they are detached by a process of ulceration, analogous to what happens in the separation of sloughs; and an ulcerated and suppurating surface is left, remarkable for the large size, the florid color, the great vascularity, and the rapid growth of its granulations. The cicatrization of such an ulcer as this, though generally proceeding with great rapidity, has a constant tendency to be arrested by the exuberance of the granulations. The cicatrix that results is usually thin, and of a bluish-red color, and is especially characterized by a great disposition to contract, becoming, after a time, puckered up, and much indurated. This process of contraction and hardening, which begins immediately on the completion of cicatrization, continues for many months, giving rise frequently to the most distressing deformities, and to the complete loss of motion and use in parts. These cicatrices are fibro-plastic and fatty, and often extend deeply between, and mat together the muscles, vessels, and soft structures of a limb, of the face, or of the neck.

The **Constitutional Effects** resulting from burn are most serious and important; they depend not so much upon the depth of the injury as upon its situation, the extent of surface implicated, and the age of the patient. Thus a person may have his foot completely charred and burned off by a stream of molten iron running over it, with far less constitutional disturbance and danger than if the surface of the trunk and face be extensively scorched to the first and second degrees; burns about the chest, the head, and the face, being far more likely to be attended by serious constitutional mischief than similar injuries of the extremities. In children, the system generally suffers more severely from burns than in adults.

The constitutional disturbance induced by burns, in whatever degree, may be divided into three stages: 1, depression and congestion; 2, reaction and inflammation; 3, suppuration and exhaustion.

1. The period of *depression of the nervous system and congestion of internal organs*,

occupies the first forty-eight hours; during which, death may occur before inflammatory action can come on. Immediately on the receipt of a severe burn the patient becomes cold and collapsed, and is seized with fits of shivering, which continue for a considerable time. He is evidently suffering from the shock of the injury; the severity of the shivering is usually indicative of the extent of the constitutional disturbance induced by the burn, and is more prolonged in those injuries that occupy a great extent of surface, even though it be only burnt to the first or second degree, than in those which, being of more limited superficial extent, affect the tissues deeply. On the subsidence of the symptoms of depression, there is usually a period of quiescence before reaction comes on; and during this period the patient, especially if a child, not unfrequently dies comatose; death resulting from congestion of the brain and its membranes, with, perhaps, serous effusion into the ventricles or the arachnoid. Besides these lesions, the mucous membrane of the stomach and intestines as well as the substance of the lungs, is usually found congested.

The pathological phenomena of this period are altogether of a congestive character. Of 15 cases in which the contents of the cranium were examined, I found congestion of the brain and its membranes, with serous effusion in all; in 14 of these cases the thoracic viscera were found to be congested in 9, healthy in 5; and of 14 in which the abdominal organs were examined, congestion of the gastro-intestinal mucous membrane was found in 12 cases, and a healthy condition in 2 only.

2. The next period, that of *reaction and inflammation*, extends from the second day to the second week. In it irritative fever sets in early, with a degree of severity proportionate to the previous depression; and, as this stage advances, it is attended by special symptoms, dependent upon inflammatory affections, more especially of the abdominal and thoracic viscera. Death, which is more frequent during this stage than in the preceding one, is usually connected with some inflammatory condition of the gastro-intestinal mucous membrane, or of the peritoneum. The lungs also are frequently affected, showing marked evidence of pneumonia or bronchitis: but the cerebral lesions are not so common as in the first stage; though, when they occur, they present more unequivocal evidence of inflammatory action. The following are the results of the *post-mortem* examinations which I have made. Of 17 cases in which the contents of the cranium were examined during this period, there was congestion, with evidence of inflammation and effusion of serous fluid, usually of a bloody character, in 14; a healthy state in the remaining 3. Of 19 cases in which the lungs were examined, there was congestion of these organs, probably inflammatory in many instances, with serum or lymph in the pleura, and redness of the bronchial mucous membrane, in 10. The lungs were hepatized in 5, and healthy in 4. The abdominal organs were examined in 22 cases; of these there was congestion of the mucous membrane, with, in some cases, evidence of peritonitis, in 11; ulceration of the duodenum in 6; a healthy state in 5.

It is in this stage of burn, that the very remarkable and serious sequela, *perforating ulcer of the duodenum*, is especially apt to occur. Mr. Curling, who first attracted attention to it, explained its occurrence by the supposition that Brünner's glands endeavor by an increased action to compensate for the suppression of the exhalation of the skin consequent upon the burn; and that the irritation thus induced tends to their inflammation and ulceration. This ulceration may, as Mr. Curling remarks, by rapidly proceeding to perforation, expose the pancreas, open the branches of the hepatic artery, or, by making a communication with the serous cavity of the abdomen, produce peritonitis, and thus cause death. It usually comes on about the tenth day after the occurrence of the injury; seldom earlier than this. The only exception with which I am acquainted was in the case of a child nine years of age, who died on the fourth day after the burn, in University College Hospital, and in whom an ulcer, of about the size of a shilling, with sharp cut margins, was found in the duodenum; the intestinal mucous membrane generally being inflamed. That these ulcers are not invariably fatal, is evident from a case mentioned by Mr. Curling, in which, on death occurring, from other causes, eight weeks after the injury, a recent cicatrix was found in the duodenum. These affections seldom occasion any very marked symptoms to indicate the nature of the mischief, the patient suddenly sinking. In some instances there is hemorrhage; though this is not an unequivocal sign, as I have several times seen it happen from simple inflammatory congestion of the intestinal mucous membrane. Pain in the right hypochondriac region, and perhaps vomiting, may also occur.

3. The period of *suppuration and exhaustion* continues from the second week to the close of the case. In it we frequently have symptoms of hectic, with much constitutional irritation from the long continuance of exhausting discharges. If death occur, it is most frequently induced by inflammation of the lungs or pleura; affections of the abdominal organs and brain being rare during this stage of the injury.

Of 7 cases in which the lungs were examined, they were found to be healthy in 1 only; being inflamed, hepatized with effusion in the pleuræ, in the remaining 6 cases. Of 7 cases in which the abdominal organs were examined, a healthy state was found in 4; inflammatory congestion in 2; and a cicatrized ulcer in the stomach in 1. Of 5 of the cases the cerebral contents were found healthy in 1 only; there being inflammatory congestion in the other 4.

Prognosis.—The influence of extent, degree, and situation, on the prognosis of burns has already been stated. The most fatal element indeed of these injuries is *superficial extent.* Not only do the cutaneous nerves become greatly irritated, and the nervous system generally suffer severely, from the shock of an extensive burn; but, the cutaneous secretion being arrested over a large surface of the skin, congestion of the internal organs and of the mucous membrane must ensue; and hence death may happen directly from this cause, or from the supervention of inflammation in the already congested parts; more particularly in the early periods of life, when the balance of the circulation is readily disturbed. The *degree* of burn influences the prognosis unfavorably rather so far as the part itself is concerned, than as the general system is affected. The most fatal *period* in cases of burn is the first week after the accident. I find that, in 50 cases of death from these accidents, 33 proved fatal before the eighth day; 27 of these dying before the fourth day. Of the remaining 17 cases, 8 died in the second week, 2 in the third, 2 in the fourth, 4 in the fifth, and 1 in the sixth.

Mode of Death from Burn.—When in an ordinary conflagration a person is "burnt to death," the fatal event is occasioned not by the charring, roasting, or actual burning of the body, but by the induction of asphyxia. Life is mercifully extinguished by suffocation in the smoke, gases, and noxious vapors resulting from the fire, before the body itself is consumed.

When a person is severely and extensively burnt, and dies in the course of a few hours, or a day or two, death arises usually from shock, which is most severe and continuous. Dupuytren was of opinion that during this stage the sufferer died from the excessive pain, and stated that "too great a loss of sensibility might kill as well as too great a loss of blood." Whether this be so or not, it is perhaps difficult to say; but the fact remains certain that, in individuals who die during this stage, the brain and its membranes will invariably be found congested, usually with more or less effusion of serous fluid into the ventricles or the arachnoid. This I have invariably found in every case that I have examined. In one half of the cases I have found congestion of the thoracic organs, and in the majority congestion of the abdominal organs, more especially of the mucous membrane of the stomach and ileum. Death during the second stage is usually dependent upon internal inflammation, more particularly of the gastro-intestinal mucous membrane and lungs, and less frequently of the brain and its membranes. If the patient survive into the period of suppuration, and then succumb, he will usually die from exhaustion, hastened or accompanied by inflammation of the lungs or pleura.

Treatment.—The treatment of burns must have reference to the constitutional condition, as well as to the local injury. A vast variety of local applications have been recommended by different surgeons, such as flour, starch, cotton-wadding, treacle, white paint, gum, solution of India-rubber, &c.; the principle is, however, the same, viz., the protection of the burnt surface from the air. I shall here content myself with describing the method that is usually followed with much success at the University College Hospital.

The *constitutional treatment* is of the utmost consequence. We have seen how death arises at various periods after these accidents from different causes, and we must modify our treatment accordingly. The first thing to be done after the infliction of a severe burn is to bring about reaction; the patient is trembling in a state of extreme depression, suffering great pain, is cold and shivering, and may sink from the shock unless properly supported. A full dose varied according to the age, of liquor opii, should be given at once in some warm brandy and water, and repeated, if necessary, in the course of an hour or two.

When the stage of reaction has fairly set in, the patient's secretions should be kept free by the administration of an occasional mild purgative and salines. Should any inflammatory symptoms about the head, chest, or abdomen manifest themselves, it will be necessary to have recourse to treatment proportionate to their nature. I have certainly seen patients saved in these circumstances by the employment of bloodletting and the application of leeches. But, in the vast majority of instances, the visceral complications are low and congestive. In such cases our great reliance must be on stimulants. Ammonia and bark, brandy and wine, require to be freely given, with a sufficiency of nourishment; and the irritability of the nervous system must be soothed by the frequent administration of full doses of opium. At a later period, when the strength has become weakened by the profuseness of the discharges, this tonic and stimulating plan must be actively continued.

Local Treatment.—The burnt clothes having been removed, the patient should be laid upon a blanket, and, whatever the degree of the burn, be well covered with the finest wheaten flour by means of an ordinary dredger. The flour should be laid on thickly, but uniformly, and gradually; it forms a soft and soothing application to the surface. If the cuticle have been abraded or vesicated, the flour will form a thick crust, by admixture with the serum discharged from the broken surface. If the skin be charred, the discharge, which will be speedily set up around the eschar, will make the flour adhere to the part, forming, as it were, a coating impervious to the air. The crusts thus formed should not be disturbed until they become loosened by the influence of the discharges, when they should be removed; and the ulcerated surface that is exposed should be dressed with water-dressing, red-wash, or lead ointment, according to the amount of irritation existing, the suppurating sore indeed being managed on ordinary principles. In some cases, lint dipped in the "*carron oil*," composed of equal parts of linseed oil and lime-water, to which a small quantity of spirits of turpentine might be added, has appeared to agree better than anything else: and in others cotton-wadding answers admirably. Whatever local application be adopted, I hold it to be of the utmost importance in the early stages of the burn to change the dressings as seldom as possible; not, indeed, until they have been loosened, or rendered offensive by the imbibition of the discharges. Every fresh dressing causes the patient very severe pain, produces depression, and certainly retards materially the progress of the case.

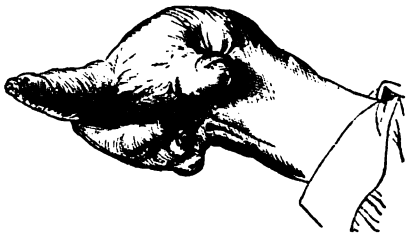
Prevention and Removal of Contraction.—As cicatrization advances, much attention should be paid to repressing the exuberant granulations by the free use of the nitrate of silver; and the position of the parts must be carefully attended to, so as to counteract, if possible, the after-contraction that ensues. With this view, the part must be properly fixed by means of bandages, splints, and mechanical contrivances, specially adapted to counteract the tendency to contraction of the cicatrix. This is especially necessary in burns about the neck, where there is a tendency for the chin to be drawn down on to the sternum, and great deformity to be thus occasioned; and in burns at the inside of limbs or the flexures of joints, more especially the elbow, where after-contraction is very apt to ensue. The contraction of cicatrices in bad burns of the hands will especially require attention, as in these cases the fingers may be drawn into and fixed upon the palm of the hand, may become webbed, or may be dislocated and fixed immovably against the dorsum. The accompanying wood-cuts are good illustrations of the bad effects of burns upon the hands. In Fig. 69 the little finger has been dislocated, and fixed upon the dorsum. In Figs. 70 and 71, the two hands were frightfully deformed—the fingers being partly consumed, and partly webbed and matted together by dense cicatricial tissues. This accident occurred in consequence of the night-shirt taking fire. The patient tried to extricate himself by drawing the burning garment over his head, but, the wristbands being buttoned, he could not withdraw the hands, which were frightfully burnt. In the early treatment of such cases, I have advantageously employed the elastic traction of India-rubber bands to counteract the tendency to contraction of the scar.

Fig. 69.

Dislocation backwards of little finger from cicatrix of a burn.

Similar contractions may occur in the foot, leaving great deformity, as in Fig. 72, where the heel is shown to be retracted, and the whole of the toes spread out

Fig. 70.



Deformity of right hand from burn.

Fig. 71.

Deformity of left hand from burn.

Fig. 72.

Deformed foot from burn.

in a fan shape. In this case amputation (Pirogoff's) was the only means left for securing a useful limb.

The contracted cicatrices resulting from burns may, if at all of recent date, be extended or stretched out by the pressure of strips of plaster, or the action of rack and pinion apparatus. The good effect of this plan of treatment is especially marked in contractions about the elbow, or in those that fix the arm to the side. These means are particularly useful in children, and indeed are so in all cases, provided the cicatrix be not too old—not more than a year; after that time it will seldom yield without division.

Operations for the removal of the effects of contraction consequent upon burns are occasionally required; and, if judiciously planned and executed, may do much to remedy the patient's condition. The operations that are practised with this view are of two kinds. 1. Simple division of the faulty and contracted cicatrix. 2. The transplantation of a flap of adjacent healthy skin into the gap left after the division of the cicatrix.

1. In the first operation, that of simply *dividing the cicatrix*, three points require special attention: 1st. That the division extend completely through the cicatrix from side to side into the adjacent healthy skin; 2d. That the incision be carried through the whole depth and thickness of the cicatrix into the healthy cellulo-adipose layer which will be found developed beneath it, and may always be recognized by its yellow color; 3d. That all contractile bands lying in this layer be fairly divided. The great obstacle to the success of this operation, however, consists in the fact that the new granulations, which spring up after the division of the contracted cicatrix, are in their turn liable to take on contractile action. After the division of the cicatrix, also, it may be found that the adjacent structures have been so rigidly fixed in their abnormal position as not to admit of extension. It may then be necessary to employ screw-apparatus, or even to divide fasciæ and tendons, before the part can be restored to its normal shape.

Care must, however, be taken in doing this, that subjacent structures of importance, such as large bloodvessels, or nerves, be not so closely connected with the cicatrix as to render wound or division of them unavoidable.

In the neck, cicatricial bands will often come into very dangerous proximity to the external jugular vein, which becomes greatly distended by the pressure thus exercised upon it. And at the elbow, which is a common seat of contraction from burns, the brachial artery may become involved in the cicatrix to a dangerous extent. I have heard of one case in which this vessel was divided in cutting through the cicatrix, when amputation of the arm was immediately resorted to.

These operations are most likely to be successful when they are practised for contractions at the flexures of the joints, as of the elbow. There, all that need be done is to divide the cicatrix down to the subjacent healthy structures, and then, by the proper application of splints or screw-apparatus, gradually to extend the limb, and allow granulation to go on in the extended position. Much caution, however, will here be necessary; for if the contraction be of very old standing, the arteries and nerves will have become shortened, and will be incapable of stretching under any force that may be safely employed.

2. Operations that are undertaken for the removal of the disfigurements that occur about the face and neck as the result of burns, require much management.

In these cases simple division of the cicatrix is insufficient; and the second operation, that of *transplantation of a flap of skin*, requires to be adopted in addition to it. After the cicatrix and all cicatricial bands have been freely divided in accordance with the rules just given, a flap of integumental structure, of sufficient size to fill the greater part of the gap, must be dissected up from the neighboring parts of the neck, chest, or shoulder, and laid into the cicatrix. There it should be fixed by two or three points of suture; but extreme care must be taken that no traction be put upon it, lest it slough. Union in such cases takes place by the second intention in the majority of instances; but a very satisfactory result is left, as is shown by the annexed figures (73, 74), taken before and after operation, and as has been illustrated in many cases by Mütter and Teale, who have particularly distinguished themselves

Fig. 73.

Cicatrix of lip and neck before operation.

Fig. 74.

The same patient after operation.

in such operations. The directions given by Teale for the restoration of the lower lip when dragged down, everted, and partially destroyed, by cicatrization following burn, are so simple, and lead to such excellent results, that I give them nearly in his own words. The everted lip is divided into three equal parts, by two vertical incisions three-quarters of an inch long, and carried down to the bone. These incisions are so planned that the middle portion between them (Fig. 75, B) occupies

Fig. 75.

Incisions in Teale's operation for cicatricial deformity of the lower lip.

Fig. 76.

Teale's operation: the flaps in place.

one-half of the lip. From the lower end of each incision the knife is carried upwards to a point one inch beyond the angle of the mouth (A). The two flaps thus marked out are freely and deeply dissected up. The alveolar border of the middle portion is then freshened. The lateral flaps (Fig. 76, C A) are now raised, united by twisted sutures in the mesial line, and supported as on a base by the middle flap, to which they are also attached by a few points of suture, leaving a triangular even surface (C C) to granulate. In addition to the division of the cicatrix, Mr. James, of Exeter, has in these case very successfully employed a screw-collar, by which the chin can be loosened from the sternum, and gradual extension of the cicatrix effected.

[Mr. Butcher, of Dublin, has practised an ingenious operation for restoring elasticity to the cicatricial flap. His method consists in scoring subcutaneously the hardened tissue with repeated incisions made with a long narrow-bladed knife. In this way the matted cicatrix may be unfolded as it were, and made available for the surgeon's use in an autoplastic operation. (*Operative and Conservative Surgery*, p. 760.)—A.]

In severe burns of the sides of the face and neck the resulting cicatrix is sometimes so dense, resisting, and contracted, that immobility of the jaw results, and the mouth cannot be opened, or at most the teeth can only be separated to a slight extent, so as to admit liquid nourishment. In order to restore the mobility of the jaw and the power of separating the teeth in these cases, Rizzoli and Esmarch have proposed making a false joint in the lower jaw on the side burnt, immediately in front of the cicatrix. Rizzoli does this by simple division of the bone by means of a narrow saw: Esmarch recommends, as a more effectual procedure, the removal of a wedge-shaped piece of bone about three-quarters of an inch in width above, and one inch in width below. After this has been done, the patient will be able to move the jaw at the normal articulation on the healthy side, and at the false joint where the jaw has been cut across.

Warty Cicatrices.—The cicatrices of burns, especially about the neck and chest, occasionally assume after a time a projecting, red, and glazed appearance, as if they were composed of a mass of fungating granulations smoothed down and lightly skinned over. This condition, which may be looked on as a substantive disease, and resembles cheloid in appearance, has chiefly been met with in children; but I have several times seen it in the adult, in women who had been badly burnt by their dresses taking fire. In these cases I observed what I have noted in other similar instances in children; that the warty cicatrices were the seat of the most intolerable itching, which no external application seemed to relieve. I have, however, seen the pruritus mitigated by the administration of large doses of liquor potassæ. If small and narrow, these cicatrices may be dissected out: if large, they would not admit of removal without risk of considerable hemorrhage, as, though fibroid, they are very vascular.

The cause of this peculiar outgrowth of dense cicatricial tissue is altogether unknown. It may in some cases, perhaps, be owing to want of care in checking the luxuriance of the granulations; but in other cases it occurs though every attention is paid to the healing of the wound.

Amputation may be required if the burn have destroyed the whole thickness of a limb; the part charred should then be removed at once, at the most convenient point above the seat of injury. This operation may also be required at a later period, if, on the separation of the eschars, it be found that a large joint has been opened, and is suppurating; or if the disorganization of the limb be so great as to exhaust the powers of the patient in the efforts at repair. Great caution, however, should be employed in determining on the propriety of amputating when the burn has extended, though in a minor degree, to other parts of the body, lest the powers of the patient be insufficient for the double call that will thus be made upon them.

FROST-BITE.

When the body has been exposed to severe or long-continued cold, we find, as in the case of burns, that local and constitutional effects are produced.

Local Influence of Cold.—This is chiefly manifested on the extremities of the body, as the nose, ears, chin, hands, and feet, where the circulation is less active than at the more central parts. It chiefly occurs to an injurious degree in very young or aged persons, or in those whose constitutions have been depressed by want of the necessaries of life. In such persons frost-bite is less due to the low temperature to which they are exposed, than to the habitual low vitality of the extremities. The gangrene results not so much from the intensity of the cold, as from the resisting powers of the patient being below their proper standard.

In the first degree of frost-bite that calls for the attention of the surgeon, there is a feeling of stiffness, with complete numbness of the part that has been exposed to cold; it looks pale, has a bluish tint, and is somewhat shrunken. In this state the vitality of the part is not destroyed, but merely suspended. On the return of circulation and the vital actions in the affected part, a burning tingling pain is felt,

it becomes red, and shows signs of a tendency to inflammatory action. Indeed, this appearance of inflammation, often accompanied by a burning sensation, is probably the immediate consequence of extreme degrees of cold, as it is experienced on touching solidified carbonic acid or frozen mercury.

In the next degree of cold, the vitality of the part is completely destroyed; all sensibility and motion in it are lost, it becomes shrunken and livid; but though its vitality may have been annihilated by the immediate application of the cold, it is not until the part has become thawed that gangrene usually manifests itself; it then appears to do so by the violence of the reaction induced, the part rapidly assuming a black color, becoming dry, and separating eventually, as all other mortified parts do, by the formation of a line of ulceration around it.

The *constitutional effects* of a low temperature need not detain us. It is well known that, after exposure to severe or long-continued cold, a feeling of heaviness and stupor comes on, and gradually creeps on to an overpowering tendency to sleep, which, if yielded to, terminates in coma, and a speedy, though probably painless, death.

Treatment of Frost-Bite.—This consists in endeavoring to restore the vitality of the frozen parts. In doing this the great danger is, that reaction may run on to so great a degree as to induce sloughing of the structures, the vitality of which has already been seriously impaired. In order to prevent this accident, the most gradual elevation of temperature must be had recourse to for restoring the part. The patient should be placed in a cold room, without a fire, any approach to which would certainly lead to the destruction of the frost-bitten members. These must then be gently rubbed with snow, or cloths dipped in cold water, and held between the hands of the person manipulating: as reaction comes on, they may be enveloped in flannel or woollens, and a small quantity of some warm liquid or spirit and water may be administered to the patient. In this way sensibility and motion will be gradually restored, often with much burning and stinging pain, redness, and vesication of the part. If gangrene have come on, or if the reaction run into sloughing, the sphacelated part, if of small size, should be allowed to detach itself by the natural process of separation, which should be as little interfered with as possible, the vitality of the parts continuing at a low ebb, and extension of gangrene being readily induced. If the gangrened parts be of greater magnitude, amputation of the limb may be required. This should be done at the most convenient situation for the operation, so soon as the line of separation has fully formed.

If the person who has been exposed to cold be apparently dead, he must be put in a cold room, the temperature of which must be very slowly raised. Friction, as just described, should be practised, and artificial respiration set up. These means must be continued for a long time, even if no signs of life appear: there being on record instances of recovery after several hours of suspended animation.

[To relieve the excessive burning and itching which attend the lesser degrees of frost-bite, or chilblains, I have found nothing so effective as frequently painting the part with a weak solution of nitrate of silver (gr. iv–f℥j), as recommended by Mr. Skey in cases of superficial burn.—A.]

CHAPTER XI.

INJURIES OF BLOODVESSELS.

INJURIES OF VEINS.

VEINS are very commonly wounded suicidally, accidentally, or in surgical operations; but, unless they be deeply seated, their injuries are seldom attended by any serious consequences. Occasionally subcutaneous rupture or laceration of a vein takes place from a blow or strain. In such cases extensive extravasation of blood will occur, which, however, usually undergoes absorption in a few weeks; but it may suppurate, or take on itself the changes described at page 126. This accident is most commonly seen in the saphena vein.

There are three sources of danger in open wounds of veins: 1. Loss of blood; 2. Diffuse inflammation of the vessel; 3. Entrance of air into the circulation.

1. A vein is known to be wounded, when dark blood flows in a rapid and uniform stream from the seat of injury. If the vessel wounded be one of considerable magnitude, or in close proximity to the centre of the circulation, the flow of blood may be rapidly fatal, more especially if its escape be favored by the dependent position of the part.

The *hemorrhage* from a wounded vein may, if the vessel be superficial, be arrested by position, and the pressure of a compress, with a few turns of a roller. If the vein be one of considerable size, as the internal jugular, or if it be so situated that pressure cannot be brought to bear on it, it may require the application of a ligature; but this should, if possible, always be avoided, inasmuch as it is apt to occasion dangerous inflammation of the vessel.

[The statement of the author as to the danger of ligating veins is not in accordance with the general experience of American surgeons. (See in connection with this subject an elaborate and exhaustive paper on ligation of the internal jugular vein, by Dr. S. W. Gross, in *Amer. Journ. of Med. Sciences*, January and April, 1867.)—A.]

The wound in a vein is healed by slight inflammation taking place about the lips of the incision, and giving rise to the formation of a distinct cicatrix.

2. In some cases, from the irritation of the simple wound, and in others from the application of the ligature, a *diffuse form of inflammation of the vein* takes place, which usually proves fatal. This variety of phlebitis will be described when we come to speak of the different kinds of venous inflammation.

3. The *entrance of air into veins*, being a subject of much importance, will be discussed in a subsequent chapter.

INJURIES OF ARTERIES.

Arteries may be bruised, torn, punctured, or cut.

Contusion.—A slight bruise of an artery is not attended by any bad consequences; but, if the contusion be severe, obliteration of the vessel by adhesive inflammation may ensue some days after the accident. Thus, a patient was admitted into University College Hospital under Mr. Quain, with a contused wound in the axilla, received in falling upon some iron railings; no change took place in the circulation of the arm for two days, when pulsation in the radial artery ceased, the injured vessel having evidently become obliterated by adhesive inflammation.

Rupture and Laceration.—An artery may be torn either partially or completely across. When *partial rupture* occurs, the internal and middle coats only give way, the toughness of the external coat preventing its laceration. This accident is especially apt to occur in consequence of blows or strains upon diseased or weakened vessels, and thus may possibly lay the foundation for aneurism. In other cases, the ruptured portion of the coats becomes turned down into the inside of the vessel, and, acting as a valve, prevents the further progress of the blood through it, thus giving rise to gangrene of the limb. In some cases the partially ruptured vessel becomes blocked up by plastic matter, occluding its interior, but without producing gangrene.

The *complete rupture* of an artery may occur either in an open wound or under the integuments. When an artery is torn across in an open wound, as in the avulsion of a limb by machinery, or by a cannon shot carrying it off, there is usually but little hemorrhage, even from arteries of the magnitude of the axillary or the femoral, and though the vessel hang out of the wound, pulsating to its very end. The absence of bleeding is owing to the internal and middle coats, which are fragile, breaking off short and contracting somewhat; while the external coat and the sheath of the vessel, being elastic, are dragged down and twisted over the torn end of the artery, so as completely to prevent the escape of blood.

When the laceration of the artery is subcutaneous, as occasionally happens in the attempted reduction of an old dislocation of the shoulder, either extensive extravasation, or one or other of the varieties of *traumatic aneurism*, to be described in another chapter, may be produced.

Wounds of arteries, whether punctured or cut, may be divided into those that

do not penetrate into the interior of the vessel, and those by which it is completely laid open.

Non-penetrating wounds of arteries are very rare. Mr. Guthrie, however, relates the case of a gentleman who cut his throat, and in whom the carotid artery was exposed and notched through the external and middle coats only; the vessel finally gave way on the eighth day, death ensuing. A case has also occurred at the London Hospital, in which a suicidal wound of the throat had exposed the carotid artery. After death, it was found that the inner and middle coats of the vessel had been divided by the pressure of the knife, which was blunt, but that the external coat had been left entire, and under this a dissecting aneurism was found.

In *penetrating wounds* of an artery, there is always hemorrhage of an arterial character, unless the puncture be so fine as to be closed by the mere elasticity of the coats of the vessel. Thus, Maisonneuve has shown that an artery may be punctured with a fine needle, without any hemorrhage or other unfavorable event resulting. If, however, the puncture be larger than this, being made by a tenaculum or hook, it does not commonly close in this way; and, if hemorrhage do not take place immediately, it will probably come on in the course of a few hours or days, from ulceration of the vessel. If the wound be larger than this, there is always an amount of hemorrhage proportionate to its size and to that of the vessel.

The *direction* of the wound in the artery influences materially its characters. If the cut be parallel to the axis of the vessel, there is less tendency to gaping of the edges than if it be oblique. In transverse wounds of arteries, the retraction of the coats is so great as to cause the wound to assume somewhat of a circular appearance. If the artery be cut completely across, there is always a less degree of hemorrhage than when it is partially divided; for the retraction and contraction of the cut ends may then be sufficient to close the vessel, which is not the case when it is merely wounded. When the wound in the artery is subcutaneous, communicating only by an oblique and narrow aperture with the surface, little, if any, external hemorrhage takes place, but extravasation of blood occurs. The extravasation may either be poured into one of the serous cavities, or it may be diffused in the areolar tissue of the limb or part, infiltrating it deeply and extensively, and perhaps by its pressure ultimately producing gangrene; or it may be effused in a more circumscribed manner, giving rise to one or other of the forms of traumatic aneurism.

HEMORRHAGE FROM WOUNDED VESSELS.

Local Signs.—The characters of the bleeding or hemorrhage differ according to the nature of the vessel from which the blood escapes. When a *vein* is wounded, the blood that is poured out is of a dark color, and flows in an uniform stream; the force with which this is projected depending on the conditions in which the wounded vein is placed. If there be any pressure between the wound and the heart, as of a ligature upon the vessel; if the position of the part be such as to favor the gravitation of the blood towards the wound; or if the muscles of the limb be made to contract, the force of the flow of blood will be increased.

When an *artery* is wounded, the blood that escapes is of a bright vermilion or scarlet color. It flows by jets, synchronous with the contractions of the left ventricle; between each jet the flow does not cease, but the stream becomes continuous. In the great majority of cases the jet comes only from the proximal aperture, dark blood issuing from the distal opening in a continuous and trickling stream; but in some situations a jet of blood of arterial character may issue from the distal as well as from the proximal end of the cut vessel, as in wounds of the palmar and plantar arches, or of the arteries of the forearm. As the blood flows, the jet lessens in height, in consequence of the weakening of the heart's action. The height and force of the jet in all cases depend greatly on the size of the vessel; thus the jet from the femoral artery is stronger than that from a muscular branch of the thigh. When a small arterial branch is wounded near its origin from the main trunk, the jet will always be forcible and free; so also the proximity to the centre of the circulation will influence materially the force with which the blood is propelled from the wound in the vessel.

Extravasation.—When the blood is not poured out on the surface, but escapes from a wounded vessel into the areolar tissue of a part, the substance of organs, or internal cavities, it is termed an *extravasation*. In these cases there are not the

ordinary local signs of an external hemorrhage; but other local phenomena, such as swelling, dulness on percussion, displacement of organs or parts, discoloration of the skin and subjacent areolar tissue, indicate that blood is being poured out subcutaneously; and we judge of the quantity of the blood that has escaped, not only by the extent of these local phenomena, but by the general effect produced upon the system by its loss.

Constitutional Effects of Hemorrhage.—These depend upon the quantity of blood lost, on the rapidity with which it is poured out, on the state of the patient's constitution, and on the vessel which furnishes the bleeding.

When a large quantity of blood is suddenly lost, as when a main artery is cut across or an aneurism bursts, the patient may die forthwith; falling down in a state of syncope, with a pale cold surface, lividity about the lips and eyes, and a few gasps, sighs, great restlessness, and convulsive movements of the limbs before he expires. If the quantity lost be not so great as to produce death, but be yet very considerable, the patient becomes faint and sick, with coldness and pallor of the surface, great restlessness and agitation, thirst, noises in the ears, and failure or complete loss of sight. If the quantity lost, though considerable, be not so great as this, or be spread over a greater interval of time, so that the patient is enabled to rally between the recurrences of the hemorrhage, a state of anæmia will be induced, characterized by pallor of the skin and of the mucous membranes, palpitation of the heart, rushing noises in the head, amaurosis, a tendency to syncope when in the erect position, œdema of the extremities, and general debility of the system.

After excessive loss of blood the patient may gradually rally, and, as the vital fluid is reproduced in his system, he may recover without any bad effects; or he may fall into a state of anæmia, which may perhaps never be completely recovered from, and may be associated with various forms of local debility and disturbance of functions. After very abundant loss of blood, "hemorrhagic fever" is apt to set in, characterized by a tendency to reaction in the system, with extreme irritability of the heart and arteries. It is irritative fever conjoined with anæmia. There is but a small quantity of blood in the system, and the heart and arteries make violent efforts to drive it forwards. This condition is marked by the symptoms of extreme loss of blood, alternating with periods of intermittent reaction; the pulse becomes much hurried, fluttering, jerking, and irregular in force and frequency; there is slight flushing of the face and brilliancy of the eyes, rapidly passing again into pallor and syncope; and if the hemorrhage eventually prove fatal, delirium and convulsions, with excessive restlessness, usually precede death. The rallying power is greater in the young than in the old. In advanced life blood is slowly reproduced; and a great loss of so complex a fluid, whether by accident or in an operation, is seldom completely recovered from, and often leads to the development of dangerous or even fatal secondary diseases of a low type. As has already been stated at page 37, it is in this way that excessive loss of blood at an operation, as for stone in an aged man, often proves indirectly and remotely fatal. The body of a person who has died from the effects of hemorrhage presents a peculiarly blanched, semi-transparent, waxen look; the lips, alæ of the nose, and finger-nails, have a somewhat livid appearance, contrasting strongly with the clear, yellowish-white hue of the general surface. Arterial is more dangerous than venous hemorrhage. The same quantity of blood poured out from a wounded artery will produce a greater effect on the system than an equal loss of blood from a divided vein. Children bear the loss of blood badly—a very small quantity may induce fatal syncope in infants.

Treatment.—The *general treatment* of hemorrhage is sufficiently simple. After the flow of blood has been arrested by proper local means, such as will hereafter be described, the effects of its loss are usually speedily recovered from by rest and good nourishment. In some cases, however, the nutritive process becomes permanently impaired, and a state of chronic anæmia is induced; which, notwithstanding the administration of chalybeate preparations, may continue through life, and terminate in cachexia, phthisis, or diarrhœa.

When the loss of blood is considerable, and is attended by symptoms of much prostration, it may be necessary to have recourse to immediate measures in order to prevent the syncope from being fatal. With this view the patient should be laid recumbent, with the head low; and pressure may be exercised upon the abdominal aorta or the main arteries of the limbs, so as to confine the blood as much as possible to the nervous and circulatory centres. If death appear imminent from the effects

of the hemorrhage, as happens in some cases of flooding, transfusion of blood may be had recourse to; the influence of which, in restoring the failing powers of the heart and nervous system, is immediate and most striking, and has been unquestionably determined by the observations of Dr. Blundell and other obstetricians.

The operation of *transfusion* is one of some delicacy, and requires care, lest mischief be occasioned by the injection of air together with the transfused blood—an accident that would probably prove fatal to the patient. If the proper transfusing apparatus, such as Higginson's or Blundell's, by which the blood may be injected without the risk of admixture of air, and of a proper temperature, be not at hand, an ordinary hydrocele-syringe, capable of holding about six ounces, and fitted with stopcock and canula, may be used. An opening of sufficient size having been made in one of the larger veins at the bend of the arm or about the instep, and the canula having been introduced for about an inch, the syringe, previously warmed, should be filled, and about twelve ounces of freshly-drawn human blood slowly but steadily injected, the limb being placed in such a position as to favor its transmission to the heart. In performing this operation the principal points to be attended to are: the proper introduction of the canula into the vein with as little injury as possible to its coats; the perfect freedom of the whole apparatus from bubbles of air; and the steady but rapid performance of the operation, so as to avoid coagulation and deterioration of the blood. If transfusion be determined on, it should not be delayed until the last moment, when the agony of death has already commenced; as then the actions of the nervous and circulatory systems may be so impaired that the patient is no longer recoverable, or, if temporarily so, will speedily relapse into a state of fatal disease.

The *local treatment* of hemorrhage will be fully described in the next chapter.

CHAPTER XII.

ARREST OF ARTERIAL HEMORRHAGE.

THE arrest of arterial hemorrhage is perhaps the most important topic that can engage the surgeon's attention, as on the safe accomplishment of this the success of every operation is necessarily dependent. In studying this subject we must first investigate the means that are adapted by nature for the suppression of the hemorrhage; and, secondly, the imitation of these by surgical art.

NATURAL ARREST OF HEMORRHAGE.

The history of the investigations into the means adopted by nature for the arrest of hemorrhage is full of interest to the surgeon, and is excellently given in Jones's work on hemorrhage. No subject in surgery affords a stronger evidence of the advantages of the application of "Experimental Pathology" to practice, than this, as our knowledge of it has been wholly gained by experiments on the lower animals.

Petit, who published several memoirs on this subject in 1731 and following years, states that hemorrhage is arrested by the formation of two clots—one outside the vessel, which he calls the "Couvercle;" the other inside, the "Bouchon:" the first being formed by the last drops of blood that issue, the second by the few drops that are retained. These clots by their adhesion stop the bleeding. When a ligature is applied, a similar clot forms above and below it. He recommends compression and the support of the clot.

Morand, in 1736, added much of interest. He admitted the formation of coagula, but insisted on the changes in the artery itself; which, he showed, became corrugated, contracted, and retracted. Morand entertained erroneous views as to the structure and functions of arteries, but he established the great fact that changes occur in the artery itself.

Kirkland, in 1763, wrote an excellent treatise on the subject. He showed that hemorrhage was lessened by swooning, and that an artery contracted up to its

nearest collateral branch; and he was of opinion that the coagulum did not arrest the bleeding. His views were adopted and supported by White, Gooch, Aikin, and other surgeons of his day.

J. Bell took a retrograde step by denying the retraction and contraction of the artery, and the importance of the internal coagulum, and by attributing the arrest of hemorrhage solely to the injecting of the surrounding areolar tissue with blood.

It was not until 1805 that Mr. Jones, by a series of admirably conducted investigations, finally determined the mode in which the arrest of hemorrhage takes place. Since his time but little has been added to our knowledge of the subject, so complete was his examination of it.

The *natural arrest of arterial hemorrhage* is effected by means that in the first instance are *temporary*, but afterwards *permanent*.

Temporary Means.—The means which arrest temporarily the flow of blood from an artery are threefold. If the vessel be small, as the facial or radial, they are sufficient in many cases to stay the hemorrhage without the interference of the surgeon; and, whatever be the size of the vessel, his operations are materially assisted by the effort which nature makes, though it may be an unsuccessful one, to prevent a fatal escape of blood. They consist in:—

1. The coagulation of and an alteration in the constitution of the blood.
2. A diminution of the force of the heart's action, and consequently of the pressure on the inner coat of the vessel.
3. Certain changes effected in and around the artery.

1. The *coagulation of the blood* in and around the wounded artery is the first and most important means adopted by nature for the arrest of hemorrhage. Were it not for the property of coagulation possessed by the blood, that fluid would continue to drain away from any cut artery, however small, until life became extinct. But the coagulation of the blood is sufficient of itself, in most cases, and in all cases of vessels below a certain size, to close the opening in the artery and so to arrest the further escape. The *alteration that takes place in the blood* consists in an increase of its coagulability as it flows. The blood that escapes from a wounded artery has from the first a tendency to glaze and coagulate about the cut vessel, so as to offer a mechanical obstacle to the further escape of blood from it. This of itself is sufficient in the smaller vessels to arrest the hemorrhage; the more so, as has been pointed out by Hewson, in consequence of the last flowing blood being more coagulable than the first.

2. The *diminution in the force of the heart's action*, owing to the patient becoming faint or collapsed, exercises a very material influence in arresting the flow of blood from an artery. The forcible manner in which the jet of blood is propelled at each systole of the ventricle, is the principal obstacle to the coagulation of the blood around and within the cut vessel; for not only does the movement of the blood prevent coagulation, but, so long as the jet is more powerful than the cohesion of the clot, it will certainly wash the coagulum away. As the blood flows, and the heart's impulse gradually lessens in force, the jet becomes lower and lower: until at last, when faintness comes on, it is almost entirely arrested, and time is afforded for the formation and the deposit of a coagulum in the vicinity of the wound. The collapse consequent on excessive and sudden loss of blood may therefore be looked upon as one of the safeguards of the patient—as one of the means adopted by nature for the removal of its own occasioning cause, and should therefore not be too speedily counteracted by stimulants or in any other way.

3. The *changes that take place in and around the vessel itself* are those upon which the final arrest of the bleeding is dependent. They consist in the *retraction* of the artery within its sheath, in the *contraction* of the cut ends and in the *formation of a coagulum* around its exterior, and in its interior.

When an artery is cut across, it immediately *retracts within its sheath*, the interior of which is left rough and uneven. Through this uneven channel the blood is projected, either flowing freely externally or being extravasated into the neighboring areolar tissue, according to the direction and state of the wound. As the blood flows over the roughened surface of the sheath, it becomes entangled in the fibres, and tends to coagulate upon them; this tendency to coagulation is favored by the increased plasticity of the blood as it flows, and by the diminution of the propulsive force with which it is carried on. By the conjoined operation of these causes a coagulum is formed, which, though lying within the sheath, is outside to, and

extends beyond, the artery; and is hence termed the *external coagulum*. It is usually somewhat cylindrical, and often looks like a continuation of the vessel, being at first perforated by a hollow track, through which the stream of blood continues to flow. As it increases, the hollow becomes closed by the concentric deposit of coagulum. The hollow track leading from the surface of the coagulum to the wound in the artery, has been especially described and dwelt upon by Amussat. This coagulum acts mechanically by blocking up the end of the artery, and also by compressing the vessel within the sheath; thus constituting the first barrier to the hemorrhage. The formation of the external coagulum is thus in a great measure dependent on the retraction of the artery within its sheath.

The next changes that take place in the artery, and, indeed, that are to a certain extent simultaneous with those that have just been described, are, its *contraction* and the formation of the *internal coagulum*.

The *contraction* of the cut artery commences immediately after its division, and may of itself be sufficient to close the smaller arteries. Thus, during an operation, we may often see an artery which, when first cut, jetted a stream of blood as large as a straw, gradually contract in size until it cease to bleed, owing simply to this contraction. In a larger artery this process is not sufficient to close completely the vessel, but merely gives its cut end a conical shape, diminishing greatly the aperture, and converting it into a kind of pinhole at the end of the artery.

In proportion as the open end of the artery is obstructed by the external coagulum and contracts in diameter, the blood is propelled with more and more difficulty through it, until at last it escapes in but a small and feeble stream, or even becomes completely at rest, allowing its fibrine to be deposited in a slender coagulum, which plays a more important part in the permanent than in the temporary arrest of the bleeding. To the formation of this *internal coagulum* the contraction of the vessel is subservient. This coagulum is slender and of a conical shape, the base being attached to the margins of the aperture in the vessel, and the apex extending upwards. It has no point of attachment except by its base, the apex and sides being perfectly free; it is at first composed entirely of coagulum of a firm fibrinous character, no exudative matter entering into its composition at this period, though after-changes of an important character occur within it. The importance of the internal coagulum as a temporary means of arresting hemorrhage, though great, has, I think, been overestimated. It is not formed at all in certain states of the blood, when that fluid is devoid of plasticity; and in some cases the proximity of a collateral branch to the cut end of the vessel appears, by preventing the stasis of the blood within it, to interfere with coagulation. Even when it is formed, it is of but little service, so far as the primary arrest of the hemorrhage is concerned, not being deposited until after the flow of blood has been checked by other means, such as the deposit of the external coagulum and the contraction of the vessel. After it is formed, it is useful in acting as a damper, and in breaking the force of the wave of blood against the cut end of the vessel. It is in the permanent arrest of hemorrhage that the internal coagulum is of great importance. After the hemorrhage from the cut artery has been arrested temporarily by the means that have been indicated, nature proceeds to secure the vessel by permanently occluding it.

Permanent closure of a cut artery is effected by two processes:—

1. Adhesive inflammation set up in the vessel and the surrounding parts.
2. Continued contraction of the artery.

1. *Adhesion.*—A few hours after the division of the artery, lymph is found to have been poured out both within and on the outside of the injured vessel. The lymph that is thrown out within the vessel forms the most important part of the internal coagulum, and tends materially to the permanent closure of the wound. It is effused from the cut surface of the internal and middle coats, around and immediately within the contracted orifice of the vessel, forming a small nodule projecting into its interior. If an internal clot have already formed, this plastic nodule is deposited underneath it, or is effused into its base; if no temporary clot have formed, a conical mass of coagulum will be deposited upon this nodule, in obedience to that law of pathology by which blood tends to coagulate upon inflamed points. When fully formed, this coagulum differs materially in structure at different points. At its base it is firm, of a brownish or buff color, and is composed principally of fibrine; above this it becomes dark, morone colored, and ends in a long tail-like projection of simple clot, which extends up to the nearest large collateral branch.

The important part of this coagulum, pathologically speaking, is its plastic base: the rest, however long it may be, is of no use in the permanent closure of the vessel; but, like the internal clot already described, merely serves to break the shock of the blood-stream.

Coincidently with these changes in the interior of the vessel, important phenomena occur on its exterior. Inflammation takes place in the sheath and in the surrounding parts, a round or ovoid mass of fibrine being here effused, which is at first mixed up with the external coagulum; the coloring matter of this, however, gradually becomes absorbed, leaving the plastic matter accumulated in a mass, and completely blocking up the end of the vessel from the outside.

2. *Contraction.*—Under the influence of the inflammation set up within and around it, the artery goes on contracting, until it embraces the included coagulum so firmly that it would appear as if this were adherent to every part of it, and some difficulty is experienced in separating them. That the coagulum and artery are not adherent I have ascertained by finding, on careful dissection, that the transverse striæ of the lining membrane of the artery are always visible, although the coats of the vessel are often stained nearly black by the imbibition of the coloring matter of the blood. The contracted vessel usually assumes a conical shape; but in some cases I have seen the contraction commence suddenly, the narrowed part being perfectly cylindrical for the distance of about an inch.

The changes that have just been described are those which take place in the proximal end of the artery. In the distal or inferior end, occlusion is effected by the same processes essentially, but the retraction and contraction of the vessels are not so complete and extensive, and the coagulum is usually smaller, both inside and outside; in some cases, indeed, the internal coagulum is deficient. The less perfect closure of the distal end may, as Mr. Guthrie suggests, be the cause of the more frequent occurrence of hemorrhage from it.

The ultimate change that takes place in the divided artery is the transformation of its cut extremity, up to the first collateral branch, into a dense fibro-cellular cord. This is effected by the plastic effusion inside and outside the artery, with the cut and contracted vessel in the centre, developing into fibro-cellular tissue.

Arrest of hemorrhage from a punctured or partially divided artery is effected in a somewhat different manner from what has been just now described; the difference consisting in the changes that go on in the neighborhood of the wound. If the wound in the soft parts covering the artery be of small size and oblique in direction, so that the blood does not escape with too great facility, it will be found that the temporary arrest of the hemorrhage takes place by an extravasation of blood occurring between the artery and its sheath, by which the vessel is not only compressed, but the relations between the wound and the aperture in the sheath are altered. This stratum of coagulated blood extends for some distance within the sheath, above and below the wound, opposite to which it is thicker than elsewhere. Coagulum may likewise be formed in the tissues of the part outside the sheath, by which the vessel is still further compressed, and the tendency to the escape of blood proportionately lessened.

The permanent closure of the puncture is effected by adhesive inflammation. Lymph may be effused in such a way as to be sufficient merely to plug the wound in the coats, or it may be in sufficient quantity to obliterate the whole of the interior of the artery, producing complete occlusion of it. In order that the wound in the artery should unite without obliterating the cavity of the vessel, but simply by the formation of a cicatrix in the coats, it is necessary that it be below a certain size; but this size will vary according to its direction. If the wound be longitudinal or slightly oblique, it will be more likely to unite in this way than if transverse. Mr. Guthrie states that, in an artery of the size of the temporal, a small longitudinal wound may sometimes heal without obliteration of the vessel, though this very rarely happens in arteries of larger size. If a vessel of the size of the femoral be opened to the extent of one-fourth of its circumference, there is no proof that the wound can heal without obliteration of the cavity of the artery; but when the longitudinal wound is very small in a large artery, little more than a puncture, closure may possibly take place simply by its cicatrization. The plastic matter forming the cicatrix is thrown out by the external coat of the artery. The internal and middle coats do not unite strongly, the aperture in them being merely filled up

by a plug of lymph; hence the artery always continues weak at this point, and may eventually become aneurismal.

If an artery of the second or third magnitude, as the axillary or femoral, be divided to one-fourth or more of its circumference, either fatal hemorrhage or the formation of a traumatic aneurism will take place. In those comparatively rare cases, however, in which the hemorrhage is arrested without these consequences ensuing, it will be found that it is so, by the vessel becoming obliterated by a plug of lymph, which is poured out at the wounded part and gradually encroaches on the cavity of the artery, until complete obliteration is produced, and the vessel at the seat of obstruction becomes converted into a fibro-cellular cord.

SURGICAL TREATMENT OF ARTERIAL HEMORRHAGE.

The object of the surgeon, in any means that he adopts for the suppression of arterial hemorrhage, is to imitate, hasten, or assist the natural processes, or to excite analogous ones. All his means act by increasing the retraction and contraction of the arterial coats, by forming an artificial coagulum, or by exciting adhesive inflammation in and around the vessel.

The danger from arterial hemorrhage, and the measures that must be adopted to meet it, vary according to the size of the vessel. Under all circumstances the surgeon should bear in mind the excellent advice given by Mr. Guthrie, never to fear bleeding from any artery on which he can lay his finger; the pressure of this readily controlling the bleeding from the largest vessels, provided it can be fairly applied, or the cut end of the artery seized between the finger and thumb. Thus, in amputation at the hip and shoulder-joints, the assistant readily controls the rush of blood from the femoral and axillary arteries by grasping them between his fingers. Above all, the surgeon should never dread hemorrhage, nor lose his presence of mind when it occurs. If recourse be had to effectual means for its suppression, it can always be at least temporarily arrested. And on no account should any one who pretends to the character of surgeon have recourse to inefficient means to stop it, and imagine that he can, by covering up the wound with rags, handkerchiefs, &c., prevent the escape of blood. These means only hide the loss that is going on, and, by increasing the warmth of the parts, prevent the contraction of the vessels, and favor the continuance of the bleeding. In all circumstances, therefore, bleeding wounds should be opened up, the coagula gently removed from their surface, by means of a piece of soft sponge or a stream of cold water, and the part well cleaned. In this way "you look your enemy in the face," and can adopt efficient means for the permanent arrest of the hemorrhage.

The flow of blood through a limb may be controlled for a *temporary* purpose, as during an operation, by the compression of the main artery by the hands of an assistant. This may be done in the lower extremity by pressing the femoral artery against the brim of the pubic bone, and in the upper extremity by compressing the subclavian against the first rib, or the brachial against the shaft of the humerus. The pressure should be made by grasping the limb with one hand in such a way that the index and middle fingers bear upon the artery, and press it directly against the subjacent bone. If the limb be large, or if long-continued pressure be required, the same fingers of the other hand should be firmly applied upon those that are already compressing the vessel. In some cases, especially when the subclavian or external iliac requires to be compressed, the handle of a large key, or the end of a desk-seal, covered with leather, will be found the most convenient instrument for applying the pressure.

In particular and exceptional instances, where the artery has become unusually deeply seated—as, for instance, where the clavicle has been pushed up above the subclavian by an aneurismal tumor—and when ordinary means fail in effecting a secure compression of the vessel, a very effectual mode of controlling the flow of blood through it has been adopted by Syme. This consists in making an incision through the skin and superficial fascia over the artery, so that the fingers of the assistant may be brought to bear almost directly upon the vessel, which may thus be securely and efficiently compressed.

In most cases, however, in which temporary compression of the artery is required, the *tourniquet* should be employed. It is far safer to trust to this instrument, than to the hands of an assistant, however steady and strong. When the tourniquet is

applied with a sufficient degree of tightness, the whole circulation through the limb may be completely arrested. This can never be done by the compression of the main trunk alone, the collateral and minor supplying vessels conveying blood into the limb independently of it. Then, again, if the operation be unexpectedly protracted from any cause, the fingers of an assistant may tire or stiffen; and, the steadiness of their pressure becoming relaxed, hemorrhage may ensue. For these reasons, surgeons almost invariably employ the tourniquet in amputations; and even the late Mr. Liston, who at one period of his career discarded this instrument, commonly employed it during the latter years of his life. There are three tourniquets used by surgeons. Petit's consists of two plates attached to a band, which is buckled round the limb over a pad that has previously been applied above the artery to be compressed (Fig. 41). By the action of a quick screw the plates can be separated, the band tightened, and the pad forced against the artery. In applying the tourniquet, care should be taken not to screw it up until the very moment when the compression is required, and then to do so quickly and with considerable force, lest venous congestion of the limb take place, by the veins being compressed before the circulation in the arteries is arrested. The horseshoe and Signoroni's and Skey's tourniquets, appear to me to have no advantage over the one described; and they possess the disadvantage of not compressing the collateral vessels, and consequently of commanding the circulation in a less perfect manner than the ordinary instrument.

The different means that may be employed for the *permanent* arrest of hemorrhage are: 1. The application of cold; 2. Styptics; 3. Cauterization with the hot iron; 4. Pressure; 5. Torsion; 6. Ligature; and 7. Acupressure.

1. **Application of cold** is sufficient to arrest the general oozing of arterial blood which is always observed on a cut surface. The mere exposure of a wound, which has bled freely so long as it has been covered up by pledgets and bandages, to the cold air, is often sufficient. When this does not succeed, the application of a piece of lint, soaked in cold water, will usually arrest the flow of blood. When it is necessary to do this speedily, as in some operations about the air-passages, a small stream of cold water may be allowed to drip into the wound, and thus cause rapid contraction of the vessels, and consequent cessation of bleeding. In cases of bleeding into some of the hollow cavities of the body, as the rectum, vagina, or mouth, the application of ice is advantageous. Its use should not, however, be too long continued, lest sloughing occur. Indeed, if cold do not speedily, almost at once, arrest the bleeding by constricting the vessels, it is better to have recourse to other and more efficient means.

2. **Styptics** increase powerfully the contraction of the vessels, and, by increasing the rapidity of formation and the firmness of the coagulum, tend to arrest the hemorrhage; they are principally used in oozing from spongy parts, or in bleeding from cavities or organs, to which other applications cannot readily be made. The great objection to their employment in some wounds consists in their tendency to modify injuriously the character of the surface, and to prevent union by the first intention. The most useful styptics are the solution of perchloride of iron, spirits of turpentine, gallic acid, and matico; the application of alum, or touching a bleeding part with a pointed stick of the nitrate of silver, is also serviceable. Of all these, the solution of the perchloride of iron, when injected into or applied upon a bleeding part, acts as the readiest and most efficient hæmostatic, coagulating the blood with remarkable rapidity, and into a very firm clot. In order to apply this or any other styptic effectually, the part should be wiped dry, all coagula removed, and a piece of lint or cotton-wool, soaked in the solution and then squeezed nearly dry, firmly applied and maintained by the pressure either of the finger or of a pad and bandage. If the bleeding proceed from a mucous canal, that should be firmly plugged with the lint so prepared.

3. **Cauterization** by means of the red-hot iron was almost the only mode of arresting arterial hemorrhage that was known to the ancients. It is now comparatively seldom employed, but yet in many cases it is of the most unquestionable utility, and superior to any other means that we possess; more particularly in those cases in which the hemorrhage proceeds from a soft and porous part that will not hold a ligature, or from the surface of which many points appear to be bleeding at the same time. A somewhat conical iron of sufficient size should be used, and the hemorrhage will often be stayed more effectually if it be applied at a black, than at a red or white heat. As the actual cautery blocks up the artery by a thick slough

or eschar, there is always danger of a recurrence of the bleeding when this separates, and the surgeon must be on his guard about the sixth or eighth day lest it break out again.

4. **Direct pressure** upon the bleeding part is a very efficient mode of arresting hemorrhage from small arteries. It is not, however, applicable to all parts of the body, as it is necessary that the vessel should have a bone subjacent to it, so as to afford a point of counterpressure; hence it cannot readily be employed in soft and movable parts, as the throat or perinæum. Pressure may be practised in various ways. Sometimes the mere uniform compression of a bandage is sufficient to arrest the hemorrhage; thus oozing from a wound may often be stopped by laying down the flaps, and applying a bandage rather tightly over them. Sometimes a weight applied upon this will tend still further to arrest the bleeding; as, for instance, by means of a shot or sand-bag laid upon the part. In the case of bleeding from hollow cavities, as the rectum, vagina, or nares, the hemorrhage may be arrested by the pressure of a plug of sponge or lint, to which sometimes a styptic may advantageously be added. When the hemorrhage proceeds from the puncture of a small or moderate-sized artery, as of the temporal or brachial, pressure should be made against the adjacent bone with a graduated compress and bandage, and be continued for one, two, or three weeks, until complete consolidation of the wound takes place, the vessel becoming obliterated. The *graduated compress* should be at least an inch in thickness, and made of a series of pledgets of lint of a circular shape, gradually diminishing in size. It should be applied with its pointed end resting over the wound in the vessel. In applying it, care should be taken that the part on which the pressure is to be exercised has been thoroughly dried of all blood, and that the artery is commanded above the wound by a tourniquet, or by the pressure of an assistant's fingers. A piece of adhesive plaster should then be laid on; and a thick slice of a phial-cork, or a fourpenny piece, wrapped in lint, being placed on this, the graduated compress should be bandaged tightly over the whole. When applied in this way, pressure acts by inducing adhesive inflammation and obliteration of the vessel at the point compressed.

5. **Torsion of cut arteries** for the arrest of hemorrhage is mentioned by Galen. The practice seems to have been forgotten until about 1828. It was revived in France by Amussat, Velpeau and Thierry; and in Germany by Fricke, who experimented upon and practised this method of treating divided arteries, with much ingenuity and perseverance. But notwithstanding the efforts made to force it on the attention of surgeons, it was gradually abandoned, even by its strongest advocates. Torsion has not found much favor amongst surgeons in this country, and has, perhaps, been too much neglected. It may be practised in various ways. Thus, Amussat recommends that the artery be drawn out for about half an inch by one pair of forceps; that it then be seized at its attached end with another forceps, and that the end be twisted off by about a dozen turns. Velpeau and Fricke advise that the end be not taken off, but merely twisted seven to eight times, according to the size of the vessel. Thierry simply seizes the artery and twists it in the direction of its axis. There can be no doubt that hemorrhage from the largest vessels may be efficiently stopped by torsion. Amussat and Velpeau repeatedly used it to close the femoral, brachial, ulnar, and radial arteries in amputations of the thigh, arm, and forearm. In torsion an artery is placed in the condition of one that is lacerated or torn through. The internal and middle coats are retracted, and the external one is twisted into a kind of screw or valve beyond them. A coagulum next forms within the vessel, blocking up its extremity; inflammation then takes place, gluing together the coats of the artery; the twisted end sloughs off, and the vessel becomes occluded up to the nearest collateral branch. Torsion was introduced as a substitute for the ligature on the theory that, whilst equally safe, there would be less suppuration, and a greater prospect of union of the wound by the first intention, as no foreign body was left in it. This advantage, however, is more fanciful than real; and experience has shown, as is admitted by the originators and strongest advocates of torsion—Velpeau and Amussat—that wounds do not unite more quickly when the arteries in them are twisted than when they are tied; the fact being that when the twisted end of the vessel is left it acts as a foreign body, interferes with union by the first intention, and favors suppuration as much as the noose of the ligature. In whatever way it is practised, more particularly when the end of the artery is twisted off, torsion possesses the great disadvantage of being less safe, and

is certainly far less readily practised, than the ligature of the larger arteries. Occasionally during an operation, however, small arteries, as muscular branches, may advantageously be pinched or twisted a few times in such a way as to arrest the bleeding from them.

[Torsion has lately been revived by several British surgeons, particularly Prof. Syme of Edinburgh, Prof. Humphrey of Cambridge, and Mr. Bryant of Guy's Hospital, London. The two former gentlemen twist off the ends of the arteries, while Mr. Bryant insists upon the importance of not carrying the process so far. He recommends *free* torsion (with a single pair of forceps) for vessels of moderate size and all in the extremities, and *limited* torsion (the vessel being held with a second pair of forceps above the point of twisting) for the large and loosely connected vessels. (*Med.-Chir. Trans.*, vol. li. 1868, pp. 199–230.)—A.]

6. **Ligature** is the means to which surgeons commonly have recourse for the arrest of hemorrhage from wounded arteries.

The ligature had been occasionally and partially employed by the later Roman surgeons; but with the decline of surgery it fell completely into disuse, giving way to such barbarous and inefficient modes of arresting the hemorrhage as the employment of the actual cautery, the performance of operations with red-hot knives, or the application of boiling pitch, or of molten lead, to the bleeding and freshly-cut surface. About the middle of the sixteenth century it was revived or reinvented by that great luminary of the French school of surgery, Ambrose Paré. But so slowly did the ligature make way amongst surgeons, that Sharpe, Surgeon to Guy's Hospital, writing in 1761, two centuries after its introduction into practice by Paré, found it necessary, in his well-known work, entitled "A Critical Enquiry into the Present State of Surgery," formally to advocate its employment for the arrest of hemorrhage from wounded arteries, in preference to styptics or the cautery, on the ground that "it was not yet universally practised amongst surgeons residing in the most distant counties of our kingdom." What, it may be asked, was the reason that it took two centuries to promulgate the use of the simplest and most efficacious means we possess in surgery—a means that no surgeon could now for a day dispense with? The reason simply was, that surgeons were totally ignorant of the means employed by nature for the occlusion of arteries; that they consequently knew not how to apply a ligature to these vessels, or what kind of ligature should be used; and that, in their anxiety to avoid the recurrence of secondary hemorrhage, and to make all safe, they fell into the very errors they should have avoided, had they been acquainted with the physiology of the processes which nature employs for the closure of the artery and the separation of the thread.

Between twenty and thirty years after the time at which Sharpe wrote, we find that Hunter introduced that great improvement in the surgical treatment of aneurism—the deligation of the artery at a distance from the sac, and in a healthy part of its course; but this great accession to the treatment of a most formidable disease was but coldly received, and ran some risk of being lost to the world in consequence of the ill-success that attended the earlier operations. In Mr. Hunter's first operation, four ligatures were used, all of which were applied so slackly as merely to compress the artery for some distance, and to avoid too great a degree of pressure at any one point; the artery was denuded, so that a spatula could be passed under it. Although in his subsequent operations Mr. Hunter contented himself with employing but one ligature, yet sometimes the vein was included in this; and he did not draw the noose tightly for fear of injuring the coats of the vessel, in accordance with the doctrine of the day—surgeons generally at this time being haunted with the dread of injuring, and thereby weakening, the coats of the artery; and, in order to avoid doing so, adopting modes of treatment that almost infallibly led to ulceration of the vessels and consecutive hemorrhage. The application of several ligatures of reserve, applied slack—the use of broad tapes—the interposition of plugs of cork, wood, agaric, or lead, or of rolls of lint or plaster, between the thread and the vessel, were some amongst the plans that were in common use. And how can we be surprised that the patients perished of hemorrhage, and that ligature of the vessel was nearly as inefficient and fatal a means of arresting bleeding as the use of a cautery, or of a button of white vitriol?

Mr. Jones, by an appeal to experiment, and by means of a series of admirably conducted investigations, showed that the very point that surgeons were anxious to avoid—the division of the coats of the vessel by the tightening of the noose—

was that on which the patient's safety depended; he also pointed out the form and size of ligature that was most safe, the degree of force with which it should be applied, and the processes adopted by nature for the occlusion of the vessel. Then a more rational practice was introduced, and then for the first time surgeons had full confidence in the use of the ligature.

Principles of Treatment of Wounded Arteries.—The whole of the doctrine of the general treatment of wounded arteries by ligature may be included in two great principles: 1, *to cut directly down on the wounded part, and to tie the vessel there;* and 2, *to apply a ligature to both ends, if it be completely divided, or to the distal as well as the proximal side of the wound, if it be merely punctured.*

These principles of treatment were distinctly laid down by John Bell;[1] but, although this great surgeon inculcated forcibly these rules of practice, surgeons appear to have been led away by the erroneous idea of applying the Hunterian principles in the treatment of aneurism to that of wounded arteries, until Mr. Guthrie, by his practice and precepts, and by adducing an overwhelming mass of proof to bear on this important question, recalled the attention of the profession to the proper and rational treatment of wounded arteries.

1. The principal reason in favor of *cutting down directly upon the wounded part of the injured vessel* is, that the ligature of the main trunk at a distance above it would only stop the direct supply of blood to the limb, but would not interfere with the anastomosing circulation: this finds its way readily into that portion of the vessel which is below the ligature, and the blood carried by it would consequently continue to escape by the distal aperture in the artery. Thus, though bright arterial blood may no longer jet from the upper part of the wound, blood which has become of a dark color, in consequence of the changes to which it is subjected in its passage through the vascular network of the limb, will continue to well out from the lower aperture in the artery, entailing the necessity of further operative procedure to restrain its flow; and, unless this be done, the patient will die of hemorrhage as surely, though perhaps not quite so speedily, as if no ligature had been applied. Thus, if a surgeon endeavor to arrest the flow of blood from a wound of the ulnar artery near the palm by ligaturing the brachial in the middle of the arm, and, when the blood bursts forth as furiously as ever, apply successive ligatures to the arteries of the forearm with as little success; he will at last, by the continued recurrence of hemorrhage, be forced to adopt the simple expedient that ought to have been had recourse to in the first instance—ligaturing the vessel at the point wounded, and thus he will at length succeed in arresting the bleeding.

Another reason for the practice now advocated is, that in some cases the surgeon cannot possibly know what artery is injured unless he seek for it in the wound itself. A large artery may, from the direction of the stab and the impetuous flow of blood that has followed it, appear to be wounded, when in reality it is only a minor branch that has been injured. Thus, for instance, in hemorrhage from a stab in the axilla, which proved fatal, notwithstanding the ligature of the subclavian artery for supposed wound of the axillary, the long thoracic was found to be the vessel divided; so also the external iliac artery has been ligatured for supposed wound of the common femoral, when in reality it was the superficial external pudic that was injured.

The rule of cutting down on the injured part of the artery applies to all cases in which the wound is still open, whatever be its condition. However deep, inflamed, and sloughy the wound; however ill-conditioned and infiltrated with pus or blood the neighboring parts may be, it may be stated as a general rule, to which, however, there are some exceptions, especially in wounds of the palmar arch, or of the secondary branches of the carotid, that there is no safety to the patient unless the vessel be cut down upon and tied at the part injured. This must always be done at any period after the receipt of the injury, so long as there is an external wound communicating with the artery. An operation of this kind is often attended with the greatest possible difficulty, not only owing to the hemorrhage that usually accompanies it and obscures the parts, but also in consequence of the inflamed, infiltrated, and sloughy condition of the tissues in the wound. In order to moderate the hemorrhage, the pressure of an assistant's fingers on the artery high up in the limb must not be trusted to; but a tourniquet should be applied so as completely

[1] "Principles of Surgery," vol. i. pp. 350, 390. 8vo. edit.

to arrest the circulation through the limb, and thus to facilitate the discovery and exposure of the injured vessel, the wound being dry. A large probe should then be passed to the bottom of the wound; and, taking this as the centre, a free incision should be made in such a direction as may best lay open the cavity with the least injury to the muscles and other soft parts. After turning out any coagula contained in the wound, and clearing it as well as possible, the injured vessel must be sought for. The situation of this may sometimes be ascertained at once by the gaping of the cut in its coats. In many cases, however, it is necessary to relax the pressure upon the artery, so as to allow a jet of blood to escape, and thus indicate the position of the aperture. The ligature may then be applied by passing an aneurism-needle under the vessel, if it be partially divided; or, if it be completely cut across, by drawing forwards the end and ligaturing it, as in an open wound. In doing this, care must be taken that the ligature be really applied to the vessel, and that a portion of the sheath infiltrated with blood, or thickened by adherent coagulum, be not mistaken for the artery. In applying the ligature in the circumstances here indicated, viz., in a wound that is sloughy and suppurating, the tissues will necessarily in a great degree have lost their cohesion and firmness; and although the arterial tissue resists the disorganizing influence of low inflammatory action much longer than areolar or muscular tissue, yet it will also have become softened and less resisting. Hence the vessel must be isolated with gentleness and care, and the ligature very carefully tied—no undue force being used. The ligature will usually separate in such cases several days before the ordinary time. The incisions down to the wounded artery should generally be made on the side of the wound itself, and through the wound in the soft tissues covering it. Guthrie, however, advises that, in those cases in which the wound passes indirectly to the principal artery from the back or outside of the limb, the surgeon need not follow the track of the wound, but may cut down on the vessel where it lies nearest the surface; then, on passing a probe through the wound, the spot at which the artery has probably been injured will be pointed out, and the ligature must then be applied in the way usual in cases of primary hemorrhage.

In *primary* hemorrhage from wound of an artery, no operation should be undertaken unless the bleeding be actually continuing. If the bleeding have been arrested, however furious it may have been, the surgeon should never, unless it burst forth again, search for the wounded vessel, nor undertake any operation. A man was brought to the University College Hospital with a deep stab in the groin, directly in the course of the external iliac artery; a very large quantity of arterial blood had been lost, but the hemorrhage was arrested on his admission by the application of pressure, &c. From the great and sudden loss of blood it was supposed that the external iliac had been punctured, but it was not thought advisable to perform any operation unless hemorrhage recurred. The bleeding did not return, the wound healing without any further trouble. In *secondary* hemorrhage the case is different. There the surgeon must be prepared to secure the vessel, even though bleeding have for the time ceased.

2. The second great principle in the treatment of wounded arteries, is that the *ligature be applied to both ends of the vessel, if it be completely cut across; or on both sides of the aperture in it, if it be only partially divided.*

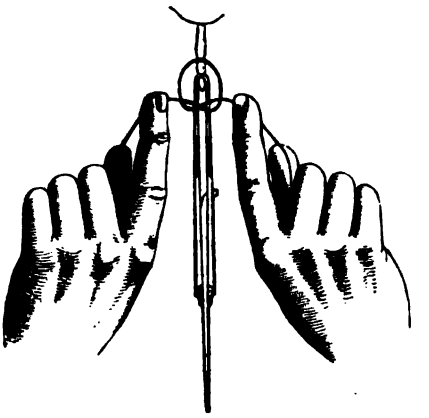
The reason for this rule of practice is founded on physiological grounds as well as on practical experience. If the anastomoses of the part be very free, as in the arteries of the palm or forearm, bleeding may continue from the distal end, uninterrupted by the ligature on the proximal side of the wound. If they be less free, it will probably issue in a stream of dark-looking venous blood in the course of two or three days. After the collateral circulation has been sufficiently established, bright scarlet blood will burst forth from the distal aperture. Experience has shown that it is in this way that secondary hemorrhage from wounded arteries commonly occurs, the bleeding coming from the distal and not from the proximal end of the vessel.

In some cases the distal end is so retracted and covered in by surrounding parts, that it cannot be found in order to be ligatured. In these circumstances, the best effect has resulted from plugging the wound from the bottom with a graduated sponge-compress. If an arterial branch happen to be divided so close to its origin that it cannot be secured, the case must be treated as one of puncture of the main trunk, which must be ligatured above and below the bleeding orifice.

Although advocating strongly the importance of the distal as well as the proximal ligature in all cases of wounded artery, I am aware that instances are on record in which the proximal ligature alone, even at a distance from the wound, has proved successful in arresting the hemorrhage; but I cannot do otherwise than regard those cases as accidentally successful, the distal end having been better plugged than usual with coagulum; and I am strongly of opinion that the rule of practice should be that which is laid down by John Bell, and so forcibly illustrated by Guthrie, viz.:—That both ends of a wounded artery be sought for, and tied in the wound itself.

Application of the Ligature.—The mode of application of the ligature, and the kind of ligature to be used, vary according as, 1, the cut end of the artery has to be tied in an open wound, or as, 2, the vessel has to be secured in its continuity.

Fig. 77.



End of artery drawn forwards. Application of ligature.

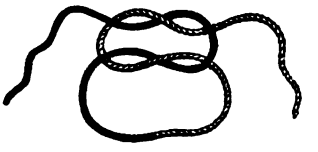
1. When the *divided vessel in an open wound* has to be tied, as after an amputation, the mouth of the artery must be seized and drawn forwards (Fig. 77). For this purpose a tenaculum, or sharp hook, is not unfrequently used, and in many cases answers the purpose exceedingly well. There are, however, some objections to this instrument; thus, it occasionally seizes other tissues with the artery, and, as it draws the vessel forwards by perforating its coats, it has happened that, an accidental puncture having been made by it behind the part to which the ligature is applied, ulceration of the vessel and subsequent fatal hemorrhage have ensued, as I have seen happen in one case. The most convenient instrument for the purpose of drawing forward the artery, and one to which no objection whatever applies, is Liston's "bull-dog" forceps. These have been conveniently modified by having the blades expanded just above the points (Fig. 78), so that the ligature can be slipped over the end of an artery that is deeply seated, as between bones or close to the interosseous membrane of the leg—a situation in which it is sometimes troublesome to tie a vessel by any other means. In some cases the bleeding point may be so situated, that the ligature is most conveniently passed under and round it by means of an ordinary curved needle.

Fig. 78.

Liston's "bull-dog" forceps, modified.

The *kind of ligature* used must vary according to the size of the vessel. If this be small, full round twine; if large, dentist's silk, or compressed smooth whip-cord should be employed. I always employ the latter in ligaturing the main artery of the limb. Before being used, the ligature should be well waxed, so that it may not be too limp; its strength should be tested by knotting it with a jerk, and, if found efficient, it may be cut up for use in pieces eighteen inches in length. In applying the ligature, care must be taken that it be put well beyond the cut end of the artery, that it clear the points of the forceps, and that it be tied tightly in a reef-knot, which does not slip (Fig. 79). One end of the ligature should then be cut off about a quarter of an inch from the knot, and the other left hanging out of the wound. The ligature that secures the main artery should have both its ends knotted together, by way of distinctive mark. It is always better to leave one end of the ligature; if both be cut off, the noose and knot left are apt to become enveloped by granulations or adhesive matter, and, after the healing process is well advanced, or perhaps completed, to give rise to suppuration in and reopening of the wound. The ligature that hangs out of the

Fig. 79.



A reef-knot.

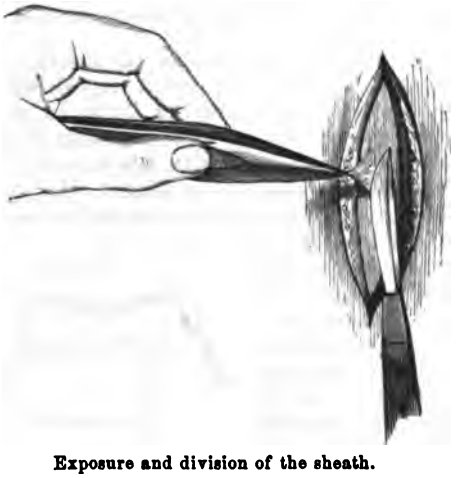
wound acts as a seton, giving rise to a tract of suppuration along its course, and thus so far preventing union of the wound by the first intention. The end of the artery which is included in, and which projects beyond, the noose, sloughs, and thus acts as a foreigu body in the wound. When the artery that is tied is small, it disintegrates and breaks down in the discharges; when it is large it separates, often attached to the noose of the ligature when that has ulcerated through the portion of the vessel that has been tied. These inconveniences are inseparable from the use of the ligature, but may be materially lessened by the surgeon bringing the threads out at the innermost angle of the wound, and thus allowing the discharges to escape at the most dependent part.

[The use of "short-cut" ligatures has recently been revived by Prof. Lister, of Glasgow, in connection with his antiseptic method. He has thus successfully tied the external iliac artery, the ligature giving no annoyance 25 weeks after the operation, and Mr. Maunder has in the same way tied the left common carotid, the wound healing over the ligature in less than a month.—A.]

2. When the artery has to be ligatured *in its continuity*, but at the point wounded, it must be exposed by as careful a dissection as the state of the parts will admit. If a surgeon determine to apply a ligature at a distance from the injury, his anatomical knowledge will guide him to the vessel. This is usually done by cutting through the tissues in the course of the vessel; Hargrave, however, recommends that, in ligaturing arteries, the incisions should not be made parallel to the course of the vessel, but in an oblique or transverse direction over it, and this suggestion appears to me to be deserving of attention in some situations, more particularly in the ligature of the brachial at the end of the arm, or of the carotid at the root of the neck. The surgeon is usually guided to the vessel by some fixed line or point, as the edge of a muscle, which has a determined and constant relation to the artery. Thus, in exposing the brachial, he cuts along the inner border of the biceps. In some cases, however, as in the ligature of the iliac arteries, no such certain anatomical guide exists, and then an imaginary line is drawn between two fixed points—as the umbilicus and the centre of Poupart's ligament—which becomes the guide to the course of the vessel. These "directing lines" should be carefully studied and kept in mind.

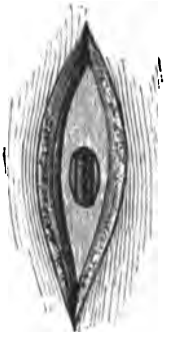
In making the first incision, the skin should be put on the stretch by the fingers of the left hand, or by those of an assistant. If the artery be superficial, or if there be parts of importance in its vicinity, the incision should not penetrate deeper than the skin. But if the vessel be deeply seated, and no parts of importance intervene, it may be carried at once through the subcutaneous areolar tissue, until the fascia covering the artery is exposed. This must then be pinched up with the forceps, and opened by the edge of the scalpel laid horizontally. Through this

Fig. 80.



Exposure and division of the sheath.

Fig. 81.



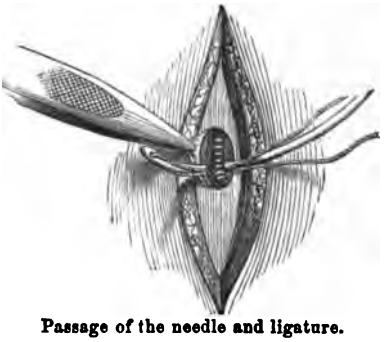
Opening in the sheath: Vessels exposed.

opening a grooved director may then be passed, and the fascia incised on it, without risk to subjacent parts. The sheath of the vessel is now exposed by a little

careful dissection; and the next step of the operation, which consists in exposing the artery and separating it from its accompanying vein, is one of great delicacy. This is done by pinching up the sheath with the forceps and applying the knife horizontally (Fig. 80). The point should never be used, nor the blade turned downwards against the artery, as an incautious movement, or the mere pulsation of the vessel might cause it to be wounded. The artery having thus been exposed, the surgeon seizes one edge of the sheath with the forceps, and, putting it on the stretch, gently separates the artery from its accompanying vein, by teazing through the areolar connections with the end of the aneurism-needle, or with a director; being careful not to expose it to a greater extent than is absolutely necessary for the passage of the ligature, lest subsequent sloughing of the vessel ensue, as a consequence of the destruction of the vascular connections between it and the sheath (Fig. 81).

In opening the sheath, care should be taken not to wound any small branch, lest the collateral supply be interfered with, and danger of secondary hemorrhage induced. The edge in the opening of the sheath being held tightly in the forceps so as to be rendered tense (Fig. 82), the ligature should then be carefully passed between the vein and artery, care being taken to include only the latter, and especially not to transfix and include a portion of the vein; an accident that often terminates fatally by phlebitis or gangrene. So also the surgeon must be on his guard not to mistake any contiguous nerve for the artery, as has happened to the most experienced operators; and also to avoid transfixing and tying a portion of the thickened sheath instead of the vessel, as I have known happen to a most excellent surgeon.

Fig. 82.



Passage of the needle and ligature.

The best *material for ligature*, when applied to the continuity of an artery, is dentist's silk or compressed whipcord, well waxed, and tied in a reef-knot, as represented in Fig. 79. Much ingenuity has been expended in devising instruments for passing it under the artery. In the majority of cases the common aneurism-needle—well ground down, but rounded at its extremity—is all that is required. Occasionally it may be advantageous to use a needle with a small curve. Many ingenious contrivances have been devised by Trant, Weiss, Coxeter, and others, for seizing and drawing forward the noose from the bottom of the wound. After the ligature has been passed under the vessel it should be tied tightly with a reef-knot, and both its ends left hanging out of the wound. The limb should then be elevated and be lightly covered with a piece of flannel, or of cotton wadding; care being taken not to apply pressure of any kind.

Modifications of the Ligature.—The application of the ligature has been modified in different ways by the ingenuity of surgeons. Some, instead of bringing the ends out of the wound, after having tied the various arteries in the usual way, and cut off the end of each ligature, draw each one out through a separate puncture in the skin. Other surgeons, again, have contented themselves with simply passing the ligature round the artery, raising the vessel in the loop of the thread, which is not tied, and bringing both ends out through a puncture made in the skin, where they are firmly fixed, so that the vessel is compressed by the loop, not tied in it. The ligature is then withdrawn, at the expiration of two or three days.

These methods appear to me to have little to recommend them. The first complicates rather than simplifies the operation; and, at each ligatured point, a tendency to ulceration might easily be established. The second method has the disadvantage of being unsafe. If the loop be drawn up tightly, it will cut through the vessel as if it had been tied. If it be left slack, there will certainly be a tendency to secondary hemorrhage.

Effects.—The immediate effects on an artery of the application of a firm round ligature with a proper degree of force, are the division of the internal and middle coats of the vessel, and the constriction of its outer one. If we examine the ligatured vessel a few days after it has been tied, we find that the coats are contracted; that there is an internal pyramidal coagulum, composed of plastic matter at its

base, and fibrinous clot towards its apex (Fig. 84); and that the ligatured portion of the vessel is surrounded by a quantity of lymph. If the artery be examined at a still later period than this—at the end of two or three months, for instance—it will be found to be converted into a fibro-cellular cord as high as the first collateral branch above the ligature (Fig. 85). Now these are analogous appearances to those met with in an artery that has been cut across and occluded without the application of a ligature, and are evidently the result of inflammation of the vessel. The question arises, how this inflammation is set up when a ligature is applied. Is it by the pressure of the noose, or by the division of the coats of the artery? That it is not the mere pressure of the ligature that excites the occluding inflammation, is evident from the experiments of Jones and of Travers, who found that, if the ligature were removed shortly after its application, sufficient inflammatory action had been excited in the coats of the artery to lead to its complete occlusion. And though any inflammation set up in the external coat may cause an effusion of lymph inside the vessel, yet that which is required to repair the breach occasioned by the division of the internal and middle coats, is the principal source of the plastic deposit. The changes that take place in the vessel after the application of a ligature require, however, to be more carefully studied.

The *division of the internal and middle coats* should be done evenly, smoothly, and completely, so as to leave a wound that will readily take on the adhesive inflammation. This is best done by a small round ligature, applied with such a degree of force that the surgeon feels the coats give way under his finger. In this a *subcutaneous* section, as it were, is effected; and this, like all similar wounds, takes on adhesive action. The adhesion between the coats is much facilitated by the pressure of the ligature, which also acts as a support to the vessel.

The *formation of the internal coagulum* in the proximal end is the most important part of the process. For the first four-and-twenty hours after the application of the ligature there is little, if any, appearance of this. Usually about this time, if opportunity offer to examine an artery in the human subject, it will be found that a small nodule of lymph, of a yellowish or buff color, has been deposited in the bottom of the cul-de-sac that is formed by the retraction and contraction of the cut ends of the inner and middle coats, so as to close up the extremity of the artery. About the second or third day, this coagulum will be found to have assumed a conical shape (Fig. 83), the base being made up of decolorized fibrine, and exudation-matter, firmly adherent to the lower end of the artery; the middle and terminal portions of the coagulum composed of fibrinous clot, and of a dark purple or morone color, lie loose and floating in the artery, extending up as high as the first collateral branch. About the tenth day, the inflamed end of the vessel will be found to be tightly and firmly contracted upon the inclosed plug (Fig. 84), the dark colored portions of which now begin to undergo a process of absorption. Between this period and the sixth week, the contraction of the vessel and the absorption of the free part of the plug go on simultaneously (Fig. 85), the interior of the artery becoming darkly stained by imbibition of the coloring matter of the coagulum. Lastly, the plastic base of the plug becomes incorporated with the contiguous arterial coats, and undergoes eventual transformation into fibro-cellular tissue.

Fig. 83.

Femoral artery, fifty-six hours after amputation.

Fig. 84.

Brachial artery, ten days after amputation.

Fig. 85.

Femoral artery, six weeks after amputation.

In some cases (Fig. 86), there is an imperfect formation of the internal plug, or even total absence of it, and not unfrequently secondary hemorrhage occurs as a consequence. This condition may arise either from want of plasticity in the blood, from an absence of due adhesive inflammation, or from the coats not having been properly cut through. In other cases, in consequence of suppurative action being set up in the artery, a kind of disintegration or liquefaction of the plug takes place after it has been formed. This I have seen happen in a case of

ligature of the carotid artery, in which death occurred from visceral disease ten weeks after the operation; and in the femoral, in cases of pyæmia (Fig. 87). In the distal cul-de-sac of the ligatured artery I have never seen any very distinct coagulum formed, either in the human subject or in dogs on which I have experimented, but merely small detached fragments of coagula and some plastic effusion.

Fig. 86.

Partial absorption of coagulum in femoral, fourteen days after amputation.

The changes that take place in the *external coat* are most important. After the internal and middle coats have been cut through by the ligature, the external would not be able to resist the impulse of the blood, were it not strengthened and consolidated by the adhesive inflammation. The necessary inflammation is occasioned partly by the dissection required to expose it, and partly by the pressure and irritation of the ligature. Lymph is thrown out between the vessel and its sheath, matting together these parts, and often enveloping the noose and knot in an ovoid mass. Progressively with the effusion of lymph and consequent strengthening of the coats, the pressure of the noose causes gradual sloughing and ulceration of the part included in it. The mode in which the noose ulcerates its way through the external coat is of much importance, as on this depends in a great measure the success of the ligature. There are two sources of danger in connection with this process; either that the sloughing may be too extensive, or that the ulceration through the artery may take place before the adhesive plug is properly and firmly formed.

Fig. 87.

Femoral arteries, ten days after amputation of thigh. Death from pyæmia.

The chance of the sloughing being too extensive, principally arises from the artery being isolated and separated from its sheath to too great an extent during the dissection required to expose it, in consequence of which, its nutrient vessels being divided in great numbers, that portion of the coats of the vessel, deprived of its vascular supply, becomes sloughy; hence the danger of passing a spatula, large probe, or the handle of a scalpel under the artery, and also of applying several ligatures. Premature ulceration of the vessel most commonly occurs from the patient's constitution being in too debilitated a state to admit of healthy reparative action.

So soon as the ligature has ulcerated through that portion of the artery which is included in its noose, it becomes loosened and separates; frequently being thrown off with the discharges, or becoming detached on the slightest traction. The period of the separation of the ligature depends upon the size of the artery and the thickness of its coats. From the radial or ulnar arteries, it is usually detached by the eighth day; from the femoral, iliac, or subclavian, about the sixteenth or twentieth day. In some cases the ligature will continue attached for a much longer period than this, owing to the inclusion of a bit of a nerve or of muscular substance within its noose. In order to hasten the separation in these cases, moderate traction and occasional twisting of the ligature may be practised.

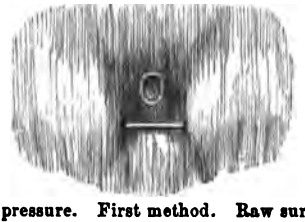
7. **Acupressure.**—By acupressure is meant the occlusion of an artery by the pressure of a needle in such a way as to arrest the circulation through or the hemorrhage from it. This method of treatment has been introduced into surgical practice by Sir James Simpson as a substitute for the ligature.

Acupressure may be applied in several different ways. There are four principal methods.

The *first* method is carried out in the following way, which I give as nearly as possible in Sir James Simpson's own words. The surgeon places the tip of the forefinger of his left hand upon the bleeding mouth of the artery which he intends to compress and close; holding the needle in his right hand, he passes it through the *cutaneous* surface of the flap, and pushes it inwards till its point projects out to the extent of a few lines on the raw surface of the wound, a little to the right of, and anterior to, his finger-tip; he then, by the action of his right hand upon the head of the needle, turns and directs its sharp extremity so that it makes a bridge,

as it were, *across* the site of the tube of the bleeding artery, immediately in front of the point of the finger with which he is shutting up its orifice; he next, either with this same forefinger of the left hand, or with the side of the extremity of the needle itself, compresses the locality of the bleeding arterial orifice and tube, and then pushes on the needle with his right hand so as to make it re-enter the surface of the wound a little to the left side of the artery; and, lastly, by pressing the needle farther on in this direction, its point re-emerges through the cutaneous surface of the flap—the site of the tube of the bleeding artery being in this way left pinned down in a compressed state by the arc or bridge of steel that is passed over it. The needle thus passes first through and from the skin of the flap *inwards* to the raw surface of the wound, and, after bridging over the site of the artery, it passes secondly from the raw surface of the wound *outwards* again to and through the skin. Sometimes the needle will be best passed by the aid of the eye alone, and without guiding its course by the finger-tip applied to the bleeding orifice. It compresses not the arterial tube alone, but the structures also placed over and around the site of the tube. When the needle is completely adjusted, all of it that is seen, and that not necessarily so, on the surface of the raw wound, is the small portion of it passing over the site of the artery (Fig. 88); while externally, upon the cutaneous surface of the flap, we have remaining exposed more or less of its two extremities, namely, its point and its head (Fig. 89). The rest of it is hidden in the

Fig. 88.



Acupressure. First method. Raw surface.

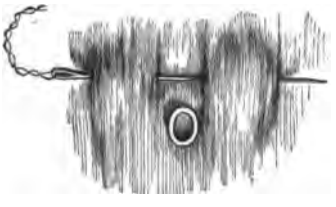
Fig. 89.

Acupressure. First method. Cutaneous surface.

structures of the flap or side of the wound. The degree of pressure required to close effectually the tube of an artery is certainly much less than surgeons generally imagine; but in the above proceeding the amount of pressure can be regulated and increased, when required, by the acuteness of the angle at which the needle is introduced and again passed out—the cutaneous and other structures of the flap serving as the resisting medium against which the needle compresses the arterial tube.

The *second method* of acupressure consists in taking a short sewing needle, with a piece of twisted iron wire attached, for the purpose of withdrawing it when necessary. This is dipped down into the soft tissues on one side of the artery; then bridged over the vessel; then dipped down again into the soft structures on the other side of the vessel (Fig. 90). In doing this, care must be taken to press the end of the needle down upon the bleeding trunk or tube of the artery with sufficient force.

Fig. 90.



Acupressure. Second method.

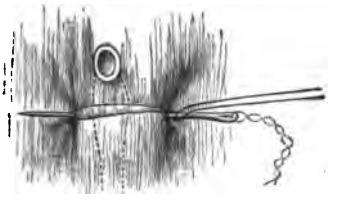
The *third method* is the one that is likely to be most frequently followed, and is, upon the whole, the most practical and the best. It consists in compressing the artery between the needle threaded with a piece of twisted iron wire, passed below or behind it, and a loop of inelastic iron wire passed over or above it. The needle is passed as in the last cases, but on the opposite side of the artery. The loop of iron wire is thrown over the point of the needle; it is then passed across the artery, drawn tight so as to compress the vessel, and secured by a half twist round the eye end of the needle (Fig. 91). In order to remove this apparatus, all the surgeon has to do is to pull the twisted wire with which the needle is threaded; this, in withdrawing the needle, liberates the loop, which may then easily be removed.

The *fourth method* consists in dipping the needle into the tissues close to the artery, then making a turn with the point, and pushing this into the soft part beyond, so as to fix it there, and thus to compress the artery (Fig. 92).[1]

[1] [This, the "Aberdeen Method," has in my hands proved more satisfactory than any other.—A.]

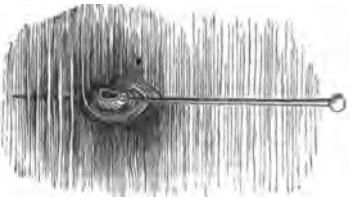
The *condition of the artery* after having been subjected to acupressure has still to be determined. Does the pressure of the needle divide, as the ligature does, the

Fig. 91.



Acupressure. Third method.

Fig. 92.



Acupressure. Fourth method.

internal and middle coats? or does it merely cause them to adhere by direct compression? In all probability the latter result is the only one obtained; a coagulum forming by the stasis of the blood between the point compressed and the nearest collateral branch. This point is one of importance; for there can be little doubt that one of the safeguards, after the ligature, is this division of the inner coats of the artery, the consequence of which is the effusion of a plastic plug within the vessel, by which it is more effectually sealed than it can be by mere cohesion of its sides and the formation of a blood-coagulum.

[Dr. Addinell Hewson has examined the condition of arteries which have been subjected to acupressure, and believes that their closure is effected by means of adhesion and the organization of plastic matter effused from the *vasa vasorum*. The inner coats of the vessels are not divided as by the ligature. (*Penna. Hosp. Reports*, vol. i. pp. 127–148.) Mr. Bryant, on the other hand, maintains that there is no adhesion after acupressure, and the sole security against hemorrhage is in the formation of an internal coagulum. (*Med.-Chir. Trans.*, vol. li. p. 202.) Finally, Mr. Lee and Dr. Beale deny that the *vasa vasorum* take any part in the closure of arteries under any circumstances, believing the repair of wounded vessels to be due to the organization of "germinal matter" derived from the blood itself. (*Ibid.*, vol. l. pp. 477–488.)—A.]

The time during which the needle should be left in will vary with the size of the artery. As a general rule, it should be from thirty to sixty hours, according to the size of the vessel. The needle must not be left in too long, lest irritation be set up, and ulceration induced along its track.

Acupressure and Ligature compared.—That arterial hemorrhage may be effectually controlled by acupressure in many cases, is undoubted. This fact has long been familiar to surgeons in the operation for hare-lip, in which the bleeding from the coronary artery is restrained by the pin that is passed across to unite the opposite sides of the cleft, and it has of late years been abundantly proved in the case of the largest arteries divided in amputation. But, though by means of acupressure arterial hemorrhage may undoubtedly be controlled, the real question which has still to be answered is, whether we are justified in substituting this means for the ligature in surgical practice. When we reflect on the ease and certainty with which the most furious hemorrhage from the largest artery can be at once and permanently arrested, by the tying of the mouth of the bleeding vessel with a silken thread—the inestimable advantage which the ligature has been and is to surgeons, in enabling them to carry the knife with safety into regions where its presence would be fatal but for this means—we should not lightly, and on insufficient evidence, throw aside a means of such tried utility for one that is of more doubtful value. And few practical surgeons will probably discard the thread for the needle in the arrest of arterial hemorrhage, unless the latter can be proved to be more certain and more safe than the former.

Sir James Simpson, who has pressed the subject of acupressure upon the attention of surgeons with an amount of zeal, of learning, and of experimental research, which is truly to be admired, advances a variety of arguments in favor of arresting arterial hemorrhage by the needle rather than by the ligature. These may briefly be summed up as follows.

The great object of every surgeon is to heal operation-wounds by the first intention.

A serious and fatal obstacle to this method of healing is the use of the ligature. The ligature acts injuriously in two ways: 1, each thread acts as a seton and sets up a line of suppuration along its track; and 2, the cut end of the artery included in and projecting beyond its noose forms a slough which increases the suppurative action, both by undergoing a process of disintegration and by acting as a foreign body in the wound. Complete healing of a wound to which a ligature has been applied cannot, therefore, possibly take place until after the separation of the ligature and the section of included arterial tube.

These evils are entirely obviated, and union by the first intention is secured, 1, by the use of metallic compressors, the needle and wire being tolerated by the tissues amongst which they lie, and not acting as setons in the way that hempen or silken ligatures do; and 2, by the early withdrawal of these compressing agents, the vitality of the artery not being endangered and no terminal slough resulting.

That these arguments are sound, it is impossible to deny. The principle on which acupressure is founded is in accordance with the fundamental doctrines of surgical pathology, and must commend itself to every practical surgeon who dispassionately considers this important question.

But, whilst I admit to the fullest the truth and pathological soundness of the principle on which acupressure is founded, and whilst I cannot but regard any method of treatment which facilitates the early healing of operation-wounds, without suppurative action, as a great step in advance of surgical practice, I cannot but think that, in estimating the comparative value of the ligature and of acupressure in the arrest of surgical hemorrhage, too much evil has been laid to the charge of the thread, and too much advantage has been claimed for the needle.

If the ligature were the sole or indeed the great cause of suppuration in wounds and of the failure of union by the first intention, it should undoubtedly be discarded in favor of any safe method that would obviate these evils. But is the ligature in reality so injurious? Are there not many causes of want of union by the first intention which are entirely independent of the method adopted for occluding the arteries? The constitutional condition of the patient, irrespective of anything in the local management of the wound, exercises a most marked influence (p. 34). The want of homogeneity of tissues (p. 54), and the very nature of the wound itself, have also a decided influence. In many wounds—as in operations for the removal of dead bone, the excisions of bones and joints, the ablation of many tumors, &c.—no attempt at union by the first intention is made; the wound is stuffed perhaps with lint, or the tissues are in such a condition that suppuration is a necessity for healing.

So, again, in amputations (p. 54), there are many circumstances that militate, and always must do so, against complete primary union. Amongst these may be mentioned the impossibility of close approximation of the flaps owing to the intravention of the bone; or, as in some amputations, as the partial ones of the foot, the very shape of the flap, and the irregularity of the osseous surfaces; the inability of cohesion between alien tissues, as bone or synovial membrane and muscle, &c. In some cases, undoubtedly, where many or deep ligatures have to be applied, the threads add to the difficulty in effecting direct union. But in many amputations it must be remembered that the chief and perhaps the only ligatures are applied to vessels that, being cut long, are on a level with the edge of the flap. This is the case in amputation of the forearm, and at the shoulder, hip, and knee-joints, in amputations of the leg low down, and in all amputations done by the long flap. In such cases, acupressure would do little to aid in accomplishing direct union.

Although, therefore, I do not consider that the ligature is in practice open to the objection which has been laid to its charge, that it is the chief obstacle to the union of wounds by the first intention, yet undoubtedly it is in many instances a hindrance to this desirable result; and, when so, it certainly appears desirable that acupressure should be substituted for it. In many instances, also, and in some even where union by the first intention is not possible, acupressure is a most convenient and safe method of arresting bleeding from vessels which it may be very difficult to expose and tie. Thus, in lacerated or incised wounds of the scalp, in injuries of the hand or foot, the bleeding may often be at once controlled by the pressure of the needle and wire.

Indeed, it appears to me, that sound as may be the principle on which acupressure is based, in practice it cannot and need not be substituted for the ligature, but that it may be employed advantageously in conjunction with it, each method being

applied to those vessels or in those cases to which and in which it seems most useful; and that the surgeon will act more wisely in being eclectic rather than dogmatic in the employment of his means for arresting arterial hemorrhage, in some cases using styptics, in others compression or torsion or the cautery, acupressure or the ligature, as the particular case seems to need it. Because one method is good, the others are not necessarily bad; because one is peculiarly applicable in one case, it does not follow that it is equally so in all.

Collateral Circulation.—When the main artery of a limb has been ligatured, or in any other way occluded, it is only the direct flow of blood that is interrupted; the indirect supply which is conveyed into the limb or part, by the free inosculations between the anastomosing vessels of the different portions of the arterial system, being sufficient to preserve its vitality, and to prevent the occurrence of gangrene. So free and ready are the communications kept up between different portions of the arterial system, that, after the largest arteries in the body, such as the subclavian, iliac, and aorta, have been ligatured, sufficient blood to support life is at once conveyed into the parts supplied by them. This *collateral circulation* is most active and most readily maintained in early life, when the vessels are pliant and elastic, readily accommodating themselves to the increased quantity of blood that they are required to convey. As age advances, the vascular system becomes less elastic, and there is a greater difficulty in the establishment and maintenance of the collateral circulation. The anastomosing vessels which serve this purpose are invariably furnished by arteries contiguous to that which is ligatured, and come off from the same side of the body. Thus, for instance, after the ligature of the superficial femoral, it is by the profunda artery that the supply of blood is carried to the lower extremity. Thus also, when the common carotid is ligatured, the circulation to the parts it supplies is not maintained through the medium of the opposite carotid, although the inosculations between the ultimate branches of the two vessels are so free upon the throat, upon the face, and within the cranium; but it is by means of the inferior thyroid and vertebral arteries (branches of the subclavian on the same side), which become greatly enlarged, that the supply of blood is kept up to the parts on the outside, as well as in the inside of the cranium.

The supply of blood that is sent to a limb, after the deligation of the main trunk, is at first but small in quantity; being merely sufficient for the maintenance of its vitality, but not enough for the continuance of the usual actions of the part. Hence, although the life of a limb may be preserved after the ligature of its artery, it becomes cold, and the patient is unable to move it for some time, the muscles appearing to be completely paralyzed; gradually, however, the supply of blood increases, until, having reached its usual standard, their normal vigor returns.

By what mechanism is this accomplished? It is due to three series of changes taking place: 1, in the capillaries; 2, in the anatomical anastomosing branches; and 3, in the trunk itself.

The *capillaries* are the first to enlarge; and this they appear to do by a vital process, and not in consequence of the mere increased pressure of the blood; the temperature of the limb often rising, in the course of a day or two, to its normal standard, and sometimes to two or three degrees beyond it, whilst a great sensation of heat is experienced in it by the patient. This period extends over several weeks; and, if opportunity be afforded of examining the limb during its continuance, the tissues generally will be found to be preternatually vascular, admitting injection freely.

Coincidently with this increase of activity in the capillary system, the *anastomosing vessels* of the part enlarge, becoming serpentine, tortuous, and waved, forming circles or an interlaced network. During this enlargement, much pain is often experienced, owing to the pressure of the enlarged vessels upon neighboring nerves. This form of collateral circulation commences by a general enlargement of all those muscular and subcutaneous secondary vessels of the limb, which can normally be readily distinguished by the naked eye. After this general enlargement has continued for some weeks, it tends to localize itself in a few of the principal anatomical inosculations, until at last it is through their medium that the circulation is chiefly maintained. Thus, for instance, after the ligature of the common carotid, the supply of blood is ultimately conveyed by the inosculations between the superior and inferior thyroid arteries, and by the vertebral and basilar. When the subclavian is tied, the circulation of the upper extremity is carried on by the anastomoses between

Fig. 93.

the posterior scapular and suprascapular, and the branches of the axillary artery distributed to the vicinity of the shoulder; and when the external iliac is tied, the blood is conveyed to the lower limb by the inosculations between the mammary and lumbar arteries, with the epigastric and circumflex ilii.

Jones pointed out the curious circumstance, that, when two anastomosing branches approach one another, they split, before inosculating, into two or three ramusculi, which by uniting form a circle of anastomoses. Besides this kind of collateral circulation, Maunoir, Porta, and Stilling have noticed vessels running directly between the extremities of the obliterated trunk, forming species of arterial shoots, springing from the stump of the vessel.

Change in the trunk after ligature.

The change that takes place in the *trunk* consists in its conversion into a fibro-cellular cord, from the point to which the ligature has been applied to the first large collateral branch below it (Fig. 93): here it becomes pervious again, and, receiving the blood poured into it through the different anastomosing channels, becomes again subservient to the purposes of circulation. Porta and Stilling have shown that after a time, down the centre of this fibro-cellular cord a small tortuous central canal becomes developed, uniting the two distant ends of the divided artery. This is probably the last change that takes place in the establishment of the collateral circulation.

The collateral circulation is occasionally not sufficiently free to preserve the integrity or vitality of the parts supplied by it. As a consequence of this, gangrene not uncommonly results, or the limb may become paralyzed or atrophied. This condition is most frequently met with in old people, from ossification and rigidity of the arterial system; or it may happen as the result of copious hemorrhage, or of an extensive transverse wound of the limb dividing many of the anastomosing vessels. It more rarely happens that we find too great freedom of the anastomoses, so as to lead to a failure of the purposes for which the ligature has been applied, by the rapid admission of blood into the distal side of the vessel, thus perhaps occasioning secondary hemorrhage.

ACCIDENTS AFTER ARTERIAL OCCLUSION BY SURGICAL MEANS.

The accidents that may follow the application of the ligature, the use of acupressure, or of compression in any way exercised upon wounded arteries, are *secondary hemorrhage* and *gangrene of the limb*.

Secondary or Recurrent Hemorrhage.—By this is meant, bleeding from any cause after the employment of the means above mentioned. This accident may arise from a variety of circumstances, which may be divided into two great classes: 1. *Local Causes*, dependent on the vessel or ligature; and 2. *Constitutional Causes*, connected with some morbid condition of the constitution or blood, in consequence of which those changes which are necessary for occlusion of the artery do not take place.

Local Causes.—Among this class of causes may be mentioned any *imperfection in the application of the ligature, needle, or compress;* as, for instance, the ligature being tied too loosely, or with the inclusion of a portion of nerve, vein, or muscle; so also the accidental puncture of the artery above the point to which the ligature is applied.

The *rush of blood through a neighboring trunk or collateral branch* immediately above the ligature, has been considered as likely to interfere with the formation of the internal plug; but too much importance should not be attached to this, for Porter has tied the carotid successfully within one-eighth of an inch of the brachiocephalic artery; Bellingham has ligatured the external iliac close to its origin; and Key, the subclavian in the vicinity of a large branch, without secondary hemorrhage ensuing. But although the ligature may be safely applied near a branch on its proximal side, I think that the presence of a collateral branch in close proximity to the *distal* side of the ligature—more especially if it be one that serves to carry on the anastomosing circulation—will be found to have a decided tendency in preventing the occlusion of the distal end of the artery, and will thus act in favoring the occurrence of secondary hemorrhage.

The *wound of a collateral branch* immediately above the ligature, though it do not give rise to troublesome hemorrhage at the time, will, as I have seen, cause furious bleeding as the collateral circulation becomes established.

A diseased state of the coats of the artery at the point deligated or compressed will occasion rapid sloughing and unhealthy ulceration of the vessel; those plastic changes which are necessary for its occlusion not going on within it. It has happened that fatal secondary hemorrhage has occurred from a large artery, such as the femoral, in consequence of a small atheromatous or calcareous patch having given way immediately above the ligature, a day or two after its application.

Constitutional Causes.—These act by preventing the formation of a clot within, and the deposit of plastic matter without, the artery; or, if formed, causing their absorption in a few days. (Figs. 86 and 87.) Amongst the most common of these causes are those unhealthy states of the system in which *diffused erysipelatous inflammation* sets in, which is incompatible with plastic effusion. In these cases either no internal coagulum at all is formed, or if any be deposited it is weak, imperfect, and unable to resist the impulse of the blood; or, if it have already formed, it speedily becomes absorbed or disintegrated; offering no resistance to the impulse of the blood, and being washed away.

In some cases the secondary hemorrhage appears to be owing to an *excited state of the circulation*. The patient is restless, and has a quick, irritable, and jerking pulse. In such circumstances, bleeding is very apt to occur, and, if not too abundant, appears to give relief to the system.

The occurrence of *erysipelas, phlebitis, or sloughing of the stump or wound*, will prevent or arrest the necessary adhesive inflammation. Besides these conditions, there are certain states of the blood in which from disease, as albuminuria, it has lost its plasticity, and cannot yield the products of adhesive inflammation. Secondary hemorrhage is especially apt to occur in cases of *pyæmia*, provided that disease assume a somewhat chronic character. The conditions of the blood in pyæmia being incompatible with the formation of a firm and plastic coagulum within the artery, the vessel continues or becomes open, and secondary hemorrhage will certainly occur. The sloughing action set up in a wound may extend to the larger arteries, and by destroying their coats occasion secondary hemorrhage. But it must be borne in mind that the arterial tissues are usually the last of the soft tissues to slough. An artery will continue to pulsate in a wound, preserving its integrity when all around it is slough and disorganization.

Phenomena.—The occurrence of secondary hemorrhage is usually somewhat gradual, and not without warning. The blood does not burst forth in a gush at once, but appears at first in a small quantity, oozing out of the wound and staining the dressings; it may then cease to flow for a time, but breaks out again in the course of a few hours, welling up freely in the wound, and either draining the patient by repeated losses, attended by the phenomena that characterize hemorrhagic fever, or else exhausting him so that he falls a victim to some asthenic disease, such as pneumonia, erysipelas, or phlebitis. In other cases, again, after a few warnings, it may burst out in a gushing stream that at once destroys life.

The opportunities which I have had of examining the state of the vessels in several cases of fatal secondary hemorrhage, lead me fully to concur with Guthrie and Porter, that the blood in the great majority of instances comes from the distal and not from the proximal side of the wound. The greater tendency in the distal end of the vessel to bleed, appears to rise partly from the less perfect occlusion of this portion of the artery, and partly from its greater liability to slough, in consequence of the ligature interrupting its supply of blood through the vasa vasorum. It is no objection to this opinion that the fatal hemorrhage is often of an arterial character; for, though it is true that the blood which is carried to the distal end is, for the first few days after the application of a ligature, of a venous hue, yet, after the collateral circulation is once established, it gradually assumes a more scarlet tint, and at last becomes completely arterialized.

Periods at which it occurs.—Secondary hemorrhage may come on at any time between the application of the ligature and the closure of the wound. There are, however, three periods at which it is particularly apt to occur: 1. A few days after the ligature has been applied; 2. About the period of the separation of the ligature; and 3. At an indefinite time after its separation.

1. The hemorrhage which occurs a *few days after the application of the ligature*,

arises either from some imperfection in the tying of the ligature; from disease in the arterial coats, causing them to give way; from sloughing; or from want of adhesive inflammation on the face of a stump. When it arises from the latter cause, there is a general oozing or dribbling of blood from many points of the surface, rather than a gush from one orifice. In those cases in which the artery has been tied above the wound only, hemorrhage is very apt to occur at this time.

2. When hemorrhage occurs *about the time of the separation of the ligature*, it may arise from any of the causes already specified that interfere with the due formation of an internal coagulum, or that occasion ulceration and sloughing of the coats of the vessel. The occurrence of hemorrhage at this time is often connected with, or dependent upon, that peculiar irritability of the heart and arteries which has already been mentioned as a frequent cause of bleeding.

3. Lastly, in some cases in which *the ligature has separated but the wound has remained open*, the hemorrhage may take place either from the cicatrix in the artery being too weak to support the impulse of the blood; or from the coagulum being absorbed in the way already mentioned. The continuance of the open state of the wound after the separation of the ligature, is, I think, not improbably dependent upon a morbid condition of the coats of the vessel which eventually leads to hemorrhage. The length of time that will sometimes elapse between the separation of the ligature and the occurrence of hemorrhage is very remarkable; thus there is in St. Thomas's Hospital a preparation of a carotid artery, from which secondary hemorrhage took place in the tenth week after ligature; and South mentions a case of ligature of the subclavian, in which the thread separated on the twenty-seventh day, the fatal hemorrhage occurring in the thirteenth week.

The *treatment of secondary hemorrhage* must be considered, as the bleeding takes place: 1. From a stump; and 2. From an artery tied in its continuity.

In all cases of ligature of arteries, care should of course be taken to prevent, if possible, this accident, by keeping the patient perfectly quiet, giving no stimulants, having the bowels kept open and the secretions free, and avoiding any undue traction on the ligature itself.

In primary hemorrhage the rule of practice is, not to interfere by operation if once the bleeding have been arrested by other means. In secondary hemorrhage this rule of practice does not apply; but the surgeon *may* proceed to adopt effectual means for the prevention of the recurrence of the bleeding after the first outbreak, even though all flow of blood have ceased when he sees the patient; and he *must* do so, and that without delay, if the hemorrhage have recurred more than once. When once a repetition of secondary hemorrhage has taken place the patient's condition becomes most critical; the efforts of nature can no longer be trusted to for the arrest of the bleeding, and the last and fatal gush may at any moment occur. Hence the surgeon must in such circumstances lose no time; there must be no dallying, no hoping that the bleeding will not recur, no trusting to temporary and inefficient expedients, but the case must be at once and decisively taken in hand. In no circumstances is a greater amount of coolness and more surgical knowledge required, than in adopting a decisive and immediate line of action in a case of secondary hemorrhage. There is no time for delay, no time for consultation, none for reference to books; but the surgeon must act at once on his own responsibility.

1. The treatment of secondary hemorrhage *from a stump* will depend in a great measure on the degree of union that has taken place between the flaps, and on the situation of the stump.

When the hemorrhage occurs a few days after amputation, if there be but slight oozing, elevating the part, applying cold, and bandaging it tightly with a roller, so as to compress the flaps, will sometimes arrest the bleeding. If it continue, however, or become more severe, the flaps, which will have been disunited by the effusion of blood, must be separated, and the bleeding vessels sought for and tied. When the stump is sloughy, and the tissues softened, the ligatures will not hold; in these circumstances the application of the actual cautery to the bleeding points will arrest the flow of blood. If the oozing appear to be nearly general from the number of points, the flaps being somewhat spongy, I have succeeded in arresting the hemorrhage by clearing their surfaces thoroughly of all coagula, and then bringing them tightly together by means of a roller.

If the hemorrhage occur at a later period, after the tenth day, when tolerable union has taken place, and if it appear to proceed from the principal artery of the

part, an effort may be made to arrest it by the application of the horseshoe tourniquet, which occasionally will stop all further loss of blood; or, if the union that had taken place between the flaps have been broken through, the stump may be fairly opened up, the coagula turned out, and the bleeding vessel sought for and tied. If, however, notwithstanding the hemorrhage, the union between the flaps continue sound and firm, then the choice lies between three alternatives: 1. Opening up the stump, clearing away coagula, and tying the bleeding vessels at their open mouths; 2. Ligaturing the main artery just above the stump; 3. Performing the Hunterian operation, and tying the vessel high up in the limb at a distance from the stump. The course to be adopted will, I think, in a great measure depend upon the stump with which we have to do; but as a general rule I prefer in these cases adopting the first alternative, placing a tourniquet on the limb, passing the finger into the stump, and breaking up all adhesions, which are often very firm; then turning out the mass of coagula, which will usually be found distending the flaps, clearing these thoroughly with a sponge, and then tying the bleeding artery. Besides the main artery that bleeds—one of the tibials, for instance, if it be a leg-amputation—there will generally be very free oozing from many points. The more abundant of this may be stopped by the ligature passed, if the tissues are friable, by means of a nævus-needle under the vessels. The rest will cease on the application of cold water and on raising the stump. The flaps may then be brought together by strips of plaster and a bandage, and will usually very readily unite.

Should, however, the stump be inflamed, sloughy, and œdematous, and more particularly if it be merely the foot or hand that has been removed, then, instead of opening it up, and seeking for the bleeding vessel, deeply hidden in infiltrated tissues, it will be better to tie the main artery of the limb just above the flaps, or wherever it can be most readily reached. In such cases, after amputation of the foot, I have successfully tied the posterior tibial low down, just above the malleolus.

The third alternative, that of ligaturing the artery high above the stump, should, *I think*, in the first instance, be undertaken in those cases only where the amputation has been done close to the trunk, as at the shoulder-joint, or the middle or upper part of the thigh, and where consequently there is no length of limb to be nourished by the artery that is ligatured, and where opening up an almost cicatrized stump of very large size would inflict a greater shock upon the system, and more consecutive danger, than the deligation of an artery by an independent operation. Hence, although in no case of secondary hemorrhage from a leg-stump below the knee would I ligature the femoral in preference to opening up the flaps and securing the vessels in them, if this were practicable, yet in secondary hemorrhage after the amputation of the thigh, the case might be different; and here, if good union had already taken place, and the stump were not distended by coagula, the main artery might be tied. In such cases it is clearly useless to ligature the superficial femoral, as the hemorrhage may, and most probably does, proceed from some of the branches of the profunda. Ligature of the common femoral is not very successful; and upon the whole it would, I think, be safer, if all other means have been tried and have failed, to deligate the external iliac just above Poupart's ligament. In disarticulation of the arm at the shoulder-joint, the subclavian artery must be tied, either above or just below the clavicle.

In any case, the ligature of the main artery of the limb becomes the only and the last resource, where, in consequence of the softened, inflamed, infiltrated or sloughy state of the tissues, the surgeon is unable to secure the bleeding vessels in the stump itself, the ligatures cutting through the disorganized coats of the vessels.

2. When the hemorrhage occurs after a ligature has been applied *to the continuity of the vessel*, whether for injury or disease, pressure must first be tried. With this view the wound should be plugged, and a graduated compress should be very firmly and carefully applied by means of a ring-tourniquet over the point from which the blood proceeds; in this way the bleeding may occasionally be stopped. Not unfrequently, however, this will prove ineffectual, the bleeding recurring from underneath. When this is the case, what course should the surgeon pursue? He may reapply the compress once more with great care, after clearing away coagula, and drying the parts thoroughly; but should it again fail in arresting the bleeding, it is useless to trust to it again, as the hemorrhage will certainly recur, and valuable time and much blood will be lost in these fruitless attempts at checking it. The course that the surgeon should pursue in such a case as this, is a most anxious

consideration, but one on which his mind should be clearly and decidedly determined, as there is but little time for reflection or consultation, and none for referring to authorities.

If the artery be situated on the trunk, as the subclavian, carotid, or one of the iliacs, there is nothing to be done but to trust to the plugging of the wound; and in the great majority of these cases the patient will die exhausted by repeated hemorrhage.

When the artery is situated in one of the limbs, more efficient procedures may be employed. If it be one of the arteries of the upper extremity, the wound should be opened up, and an attempt made to tie both ends of the vessel again in this; should this fail, or not be practicable, the artery must be deligated at a higher point than that at which it had been previously tied; should the hemorrhage still continue, or be re-established, amputation is the only resource left.

In the lower extremity, the treatment of secondary hemorrhage occurring after ligature is replete with difficulty. Here I believe it to be useless to tie the artery at a higher point than that to which the ligature has been already applied, as gangrene invariably follows this double ligature of the arteries of the lower extremity: at least, in the two or three cases that I have seen in which recourse has been had to this practice, mortification of the limb has ensued; and in all the reported cases with which I am acquainted, a similar result has occurred. The treatment should vary according as we have the femoral artery or one of the tibials to deal with. If the hemorrhage proceed from the femoral, I should be disposed to cut down on the bleeding part of the vessel, treating it as a wounded artery, and applying a ligature above and below the part already deligated; this operation would, however, necessarily be fraught with difficulty. Should this be impracticable, or not succeed in checking the hemorrhage, I think that we should best consult the safety of the patient by amputating at once on a level with or above the ligature. Although this is a severe measure, it is infinitely preferable to allowing him to run the risk of the supervention of gangrene, which will require removal of the limb under less favorable conditions. If the secondary hemorrhage proceed from one of the tibials, it would be useless to adopt either of the preceding alternatives. If we ligatured the superficial femoral, the bleeding would not be permanently controlled, or, if it were, gangrene of the limb would in all probability set in; at least, I know of no case in which this practice has been followed without mortification occurring. In a few rare instances, however, the ligature of the popliteal has, under such circumstances, succeeded; but it has also frequently failed, rendering secondary amputation necessary, and its success is a mere matter of chance. The depth at which the tibials are situated is so great, that it would be hopeless to search for one of these vessels and attempt its deligation at the bottom of a deep, sloughy, infiltrated, and inflamed wound. In such circumstances, therefore, I think we should best consult the patient's safety by amputating the leg above the seat of wound. This is truly a severe measure; but the only other alternative that has, to my knowledge, ever succeeded, is the ligature of the popliteal; and as that, as has already been stated, has frequently failed, I think that, as a rule, we should best consult the safety of the patient by the removal of the limb at once.

If the hemorrhage occur from a wounded artery to which ligatures have already been applied above and below the seat of wound, the same treatment must be adopted as in those cases in which the bleeding takes place from the application of the ligature to the continuity of the vessel.

Gangrene following Ligature.—After the ligature of the main artery of a limb, the collateral circulation is, under all ordinary circumstances, sufficient to maintain the vitality of the part supplied by the deligated vessel. In some cases, however, it happens that the condition of the circulation in the parts below the ligature is not compatible with their life.

Causes.—The causes influencing the occurrence of gangrene in this way are the age of the patient, the seat of the operation, and the various conditions in which the limb may afterwards be placed.

The influence of *age* is not, however, so marked as might *à priori* be supposed; for, although there can be no doubt that there is less accommodating power in the arterial system to varying quantities of blood at an advanced period of life, and that there would be greater difficulty in maintaining the vitality of the limb after ligature of the artery in a man of sixty than in one of twenty-five; yet I find that,

of thirty cases in which gangrene of the lower extremity followed the ligature either of the external iliac or femoral arteries, the average age of the patient was thirty-five years, as nearly as possible the mean age at which these operations, according to Norris's Tables, are generally performed. Of these cases of gangrene, two occurred under twenty years of age, eleven between twenty and thirty, eight between thirty and forty, and nine above forty.

The *seat of the operation* influences greatly the liability to gangrene, which is much more frequent after the ligature of the arteries in the lower than in the upper extremity.

Besides these predisposing causes, gangrene after ligature may be directly occasioned by a *deficient supply of arterial blood.* In some cases this may arise from the collateral vessels being unable, in consequence of the rigidity of their coats, to accommodate themselves to the increased quantity of blood they are required to transmit; or they may be compressed in such a way by extravasation as to be materially lessened in their capacity. In other instances, again, the existence of cardiac disease may interfere with the proper supply of blood to the part.

Great *loss of blood*, either in consequence of secondary hemorrhage, or in any other way, before or after the application of the ligature, is often followed by gangrene, and is almost certain to be attended by this result if a second ligature have been applied to a higher point in the lower extremity. That a diminution in the quantity of blood circulating in the system may, under the most favorable circumstances, become a cause of gangrene after the ligature of the artery, is illustrated by the statement of Hodgson that, soon after the introduction of the Hunterian operation into Paris, it was the custom to employ repeated venesection in the cases operated on; the consequence of which was, that mortification was of frequent occurrence.

A more common cause of gangrene is the *difficulty experienced by the venous blood in its return from the limb.* This difficulty always exists even when no mechanical obstacle impedes the return, being dependent on the want of a proper *vis à tergo* to drive on the blood. The propulsive power of the heart, the main agent in the venous circulation, is greatly diminished by being transmitted through the narrow and tortuous channels of the anastomosing vessels. This difficulty to the onward passage of the venous blood may, if there exist any cause of obstruction in the larger venous trunks, be readily increased to such an extent as to choke the collateral circulation, and so cause the limb to mortify. This mechanical obstacle may be dependent upon the occlusion of the vein by inflammation excited within it opposite the ligature, by its transfixion with the aneurism-needle, or by its accidental wound with the knife in exposing the artery. When such an injury, followed by inflammation, is inflicted on a vein, which, like the femoral, returns the great mass of blood from a limb, gangrene is the inevitable result.

The supervention of *erysipelas* in the limb after the application of the ligature, though fortunately not of very frequent occurrence, is a source of considerable danger, being very apt to give rise to gangrene by the tension of the parts obstructing the anastomosing circulation. I have on two occasions seen gangrene of the fingers, from this cause, follow ligature of the vessels of the forearm.

The *abstraction of heat* from the limb, either directly by the application of cold, or indirectly by the neglect of sufficient precaution to keep up the temperature of the part, often occasions gangrene: thus Sir A. Cooper saw mortification follow the application of cold lead-lotion to the limb in which the femoral artery had been tied; and Hodgson witnessed the same result when the operation was performed at an inclement season of the year.

The *incautious application of heat* may, by over-stimulating the returning circulation of the limb, especially about that period when the rising temperature is an indication of increased action in the capillary vessels, occasion mortification. In this way the application of hot bricks and bottles to the feet has given rise to sloughing; and Liston was compelled to amputate the thigh after ligature of the femoral artery for gangrene induced by fomenting the limb with hot water.

The *application of a bandage*, even though very cautiously made, is apt to induce sloughing and gangrene. I have seen this happen when a roller was applied to the leg after ligature of the femoral artery, with a view of removing the œdema.

The *period of supervention* of gangrene of the limb extends over the first three

or four weeks after the ligature of the vessel. It seldom sets in before the third day, but most frequently happens before the tenth.

Character.—The gangrene from ligature of an artery is almost invariably of the moist kind, on account of the implication of the veins. The limb first becomes œdematous; vesications then form; and it assumes a purplish or greenish-black tint, rapidly extending up to the seat of operation. In some cases, though they are rare, simple mummification of the limb comes on; the skin assuming a dull yellowish-white hue, mottled by the streaks that correspond to the veins, and becoming dry, horny, and shrivelled, about the extensor tendons of the instep.

Treatment.—Much may be done with the view of preventing gangrene. Thus, the limb should be elevated, wrapped up loosely in flannel or cotton-wadding, and laid on its outer side after the operation. If the weather be cold, hot-water bottles may be put into the bed, but not in contact with the limb. Should there be any appearance of stagnation of venous blood, the plan recommended by Guthrie, of employing continuous and methodical friction in a direction upwards for twenty-four hours, so as to keep the superficial veins emptied, may be practised.

When mortification has fairly set in, amputation of the limb should be performed at once as the only chance of saving life, in all those cases in which the patient's constitutional powers are sufficiently strong to enable him to bear the shock of the operation. The limb should be removed at the seat of the original wound, or opposite the point at which the artery has been tied. In those cases, however, in which the gangrene follows injury of the femoral artery just below Poupart's ligament, Guthrie advises the amputation to be done below the knee, where it usually stops for a time. If the gangrene spread, with œdema or serous infiltration of the limb, the amputation should be done high up; at the shoulder-joint, or in the upper third of the thigh. In these cases a large number of vessels usually require ligature, having been enlarged by the collateral circulation.

CHAPTER XIII.

TRAUMATIC ANEURISM AND ARTERIO-VENOUS WOUNDS.

TRAUMATIC ANEURISM.

We have hitherto discussed the treatment of an injured artery having an open wound communicating with it. It often happens, however, that the case is not so simple as has been described, but that, in addition to the wound in the vessel, we have a subcutaneous extravasation of blood, with more or less pulsation, thrill, and bruit, from the projection into it of the blood from the wounded vessel. This extravasation constitutes a *traumatic aneurism*, and may arise in three ways: 1. There may be an oblique or indirect puncture into the artery, the blood furnished by which partly escapes from the wound, partly extravasates itself into the tissues around the vessel. 2. The puncture in the integuments may have been closed by plaster or bandage; and then no blood escapes externally, but, the wound in the artery continuing patent, the blood is poured out into the substance of the limb or part. 3. There may have been no external wound, but the artery may have been punctured or torn across, subcutaneously, by the spicula of a fractured bone, by a violent strain or twist of the limb, by the injury inflicted in a dislocation, or by the surgeon in his efforts to reduce it.

These traumatic aneurisms, in whatever way arising, are of two kinds, the *diffused* and the *circumscribed.*

Diffused Traumatic Aneurism.—This consists of an effusion of blood poured out by, and communicating with, the wounded or ruptured artery; limited in extent by the pressure of surrounding parts, and partially coagulating in the meshes of the broken-down areolar tissue. It has no sac; and its boundary, which is ill defined, is composed partly of this coagulum, and partly of plastic matter effused by the tissues into which it is poured out, and has a constant tendency to extend by the

pressure of the fluid blood, which continues to be projected into the centre of the tumor.

This form of traumatic aneurism is indicated by a subcutaneous, soft, and semi-fluctuating tumor, often of very considerable size, composed of extravasated blood. At first the skin covering it is of its natural color, but it gradually becomes bluish, and is thinned by the pressure to which it is subjected. If the wound in the vessel be rather large and free, there will be a distinct pulsation in the tumor synchronous with the beat of the heart, accompanied by a thrilling, purring, or jarring sensation, and often a distinct and loud bruit. In other cases, again, if the injured artery be small, or if the wound in it be oblique, and of limited size, there may be no distinct pulsation or bruit; the tumor being either indolent and semi-fluctuating, or having an impulse communicated to it by the subjacent artery. In those cases also in which the artery is torn completely across, or in which the blood that is effused coagulates very rapidly, the ordinary aneurismal bruit and pulsation may be very obscure or quite absent. In such cases, the diagnosis of the true nature and gravity of the tumor may usually be made by observing that the pulse in the arteries at a lower point is absent, and that there is great œdema of the limb.

These tumors, if left to themselves, rarely undergo spontaneous cure, but they either increase in size until the integument covering them sloughs and ruptures, or the external wound, which has been temporarily plugged by coagulum, gives way; or else they inflame and suppurate, pointing at last like an abscess, and, on bursting, giving rise to a sudden gush of blood, which may at once, or by its rapid recurrence, prove fatal. In some cases, a subcutaneous breach is made in the coagulated and plastic boundary, and, the blood becoming infiltrated into the areolar tissue of the limb or part, syncope, gangrene, and death are the results.

Treatment.—The treatment of these cases must be conducted on precisely the same plan as that of an injured artery communicating with an external wound; the only difference being that, in the case of the diffused traumatic aneurism, the aperture in the artery opens into an extravasation of blood instead of upon the surface. We must especially be upon our guard not to be led away by the term *aneurism* that has been applied to these cases, and not to treat such a condition, resulting from wound or subcutaneous laceration, by the means that we employ with success in the management of that disease. In a pathological aneurism the blood is contained within a sac, which, as will hereafter be shown, is essential for the occurrence of those changes that are necessary for the cure of the disease. In the diffused traumatic aneurism there is no sac, properly speaking; and hence these changes to which a sac is necessary, cannot take place. I doubt whether there is a case on record in which the Hunterian operation for aneurism, applied to the condition now under consideration, has not terminated in danger or death to the patient, and in disappointment to the surgeon.

The proper treatment of these cases consists in laying open the tumor by a stroke of the scalpel, removing the coagula, dissecting or rather clearing out the artery, and ligaturing it above and below the wound in it. This operation, easy in description, is most difficult and tedious in practice. The bleeding is often profuse; the cavity that is laid open is large, ragged, and partially filled with coagula; it is often with much difficulty that the artery is found under cover of these, and in the midst of infiltrated and disorganized tissues; and when it is found, it is not always easy to get a ligature to hold. It will be convenient to divide this operation into two stages: 1. Exposing the artery; 2. Passing the ligature.

First Stage.—The artery must, if at all practicable, be thoroughly compressed between the tumor and the heart by a tourniquet, or by the hand of an assistant. If it can be so commanded, the diffused aneurism may be at once and freely laid open: but if not, the surgeon must proceed more cautiously. He must make a small aperture in the most prominent part of the tumor, and introduce two of the fingers of the left hand so as to plug the wound in the integuments, and prevent the escape of blood by it. He must then pass in his whole hand if necessary, feel for the opening in the artery, and press his finger well upon this. Having ascertained that he controls the vessel thoroughly by the pressure of his left index and middle fingers, he may proceed to slit open the wound in the integuments, and clear the clots and blood thoroughly out of the sac.

Second Stage.—The surgeon will now have exposed the *posterior* part of the aneurismal cavity. But the artery is not yet cleared for the application of the ligature.

If the artery above be commanded by pressure, and there be no immediate danger of hemorrhage, this may best be done by passing a steel probe or a small sound into the open wound in the artery, dissecting down on each side of this through the posterior wall of the sac, and then passing the ligature in the usual way. But if the vessel be so near the centre of the circulation that it cannot be efficiently commanded, then the difficulties become far greater, for the surgeon must on no account remove his finger for an instant from the open wound; but, keeping it firmly and securely pressed into this, he must endeavor, by scratching through the tissues above it, to expose the artery sufficiently to make a dip with the needle round it, and thus to secure it. This part of the operation is by far the most difficult in such cases, on account of the infiltration of the parts and the thickening of the structures preventing the artery from being readily distinguished and easily cleared.

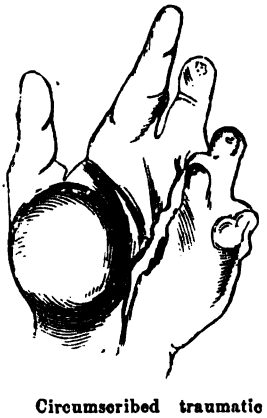
The application of a ligature to the distal end of the vessel, if it be completely divided, is especially difficult. Should it not be practicable, the application of the actual cautery, or pressure by means of a sponge-tent or graduated compress, will be found the best means of arresting the hemorrhage.

Circumscribed Traumatic Aneurism differs entirely from the diffused in its pathology and treatment, inasmuch as it possesses a distinct sac. There are two varieties of this form of aneurism.

1. In the first variety, a puncture is made in an artery, or the vessel is ruptured subcutaneously, as perhaps in the reduction of an old dislocation; blood is extravasated into the adjoining tissues; and, if there be an external aperture, this cicatrizes. The blood that is extravasated becomes surrounded and limited by a dense layer of plastic matter poured out into the areolæ of the neighboring tissues, and forming a distinct circumscribed sac, which is soon lined by layers of fibrine deposited from the blood that passes through it. This tumor, usually of moderate size, and of tolerably firm consistence, pulsates synchronously with the beat of the heart, and has a distinct bruit, both of which cease when the artery leading to it is compressed. This form of circumscribed traumatic aneurism most commonly occurs from punctured wounds of small arteries, as the temporal, plantar, palmar, radial, and ulnar.

The *treatment* to be adopted depends upon the size and situation of the artery with which the tumor is connected. If the artery be small, and so situated that it can be opened without much subsequent inconvenience to the patient, as on the temple or in the forearm, it should be laid open, the coagula turned out, and the vessel ligatured above and below the wound in it. If the tumor be so situated, as in the palm, that it would be difficult and hazardous to the integrity of the patient's hand to lay it open, the Hunterian operation for aneurism should be performed, as was successfully done in the case (Fig. 94) in which the brachial was ligatured for an aneurism of this kind in the ball of the thumb, following serious injury to the hand from a powder-flask explosion. When it is connected with the superficial palmar arch I have, however, successfully adopted the old operation of laying the tumor open, taking out coagula, and ligaturing the artery at the seat of injury.

Fig. 94.



Circumscribed traumatic aneurism in ball of thumb after a powder-flask explosion.

It is but rarely that this form of traumatic aneurism is connected with a large artery; when it is, the vessel may be ligatured above, but close to the sac, in the same way as in the next variety. If this form of traumatic aneurism have increased greatly in bulk, so that the skin becomes thin and discolored, or if inflammation ensue, and symptoms of impending suppuration take place around it, then it would be useless to ligature the artery above the tumor, as this would certainly give way, and secondary hemorrhage ensue. Here the proper course is to lay open the sac, turn out the contents, and tie the artery above and below the part that is wounded.

2. The next form of circumscribed traumatic aneurism is of rare occurrence, and usually arises from a small puncture in a large artery, as the axillary or the carotid. This bleeds freely; but, the hemorrhage being arrested by pressure, the external wound and that in the artery close. The cicatrix in the artery gradually yields,

forming, at the end of weeks or months, a tumor which enlarges, dilates, and pulsates eccentrically, with distinct bruit, having all the symptoms that characterize an aneurism from disease, and having a sac formed by the outer coat and sheath of the vessel. It is at first soft and compressible on being squeezed, but becomes harder and firmer, and cannot be so lessened after a time. It consists of a distinct circumscribed sac, formed by the dilatation of the cicatrix in the external coat and sheath of the artery, no blood being effused into the surrounding tissues.

The *treatment* will vary according to the size of the tumor. If this be small or but moderate in size, it consists in the ligature or compression of the artery leading to the sac, in accordance with the principles that guide us in the treatment of aneurism from disease; though, from the healthy state of the coats of the vessel, the artery may be ligatured as near as possible to the sac.

As there is a distinct cyst or sac in these circumscribed aneurisms, the changes that will be described in the chapter on the Treatment of Aneurisms in general take place; the tumor gradually becoming consolidated, and eventually absorbed. Should, however, the aneurism have attained an enormous magnitude, or should it, from being circumscribed, have become diffused by the rupture of the sac, then the tumor must be laid freely open, the coagula turned out, and the artery ligatured as in the ordinary diffused aneurism.

ARTERIO-VENOUS WOUNDS.

The wound in the artery may communicate with a corresponding one in a contiguous vein, giving rise to two distinct forms of disease—*Aneurismal Varix*, and *Varicose Aneurism*. These preternatural communications, which were first noticed and accurately described by W. Hunter, most commonly happen at the bend of the arm, as a consequence of the puncture of the brachial artery in bleeding; but they have been met with in every part of the body in which an artery and vein lie in close juxtaposition, having been found to occur as a consequence of wounds of the subclavian, radial, carotid, temporal, iliac, femoral, popliteal, and tibial arteries. The two forms of disease to which the preternatural communication between arteries and veins gives rise, differ so completely in their nature, symptoms, effects, and treatment, that separate consideration of each is required.

Aneurismal Varix results when, a contiguous artery and vein having been perforated, adhesion takes place between the two vessels at the seat of injury, the communication between them continuing pervious, and a portion of the arterial blood being projected directly into the vein at each beat of the pulse. Opposite to the aperture of communication between the two vessels, which is always rounded and smooth, the vein will be found to be dilated into a fusiform pouch, with thickened coats. The veins of the part generally are considerably enlarged, somewhat nodulated, tortuous, and thickened. The artery above the wound is dilated; below, it is usually somewhat contracted. These pathological conditions are evidently referable to a certain quantity of the arterial blood finding its way into the vein, and distending and irritating it by its pressure and presence, and less consequently being conveyed by the lower portion of the artery.

The *symptoms* consist of a tumor at the seat of injury, which can be emptied by pressure upon the artery leading to it, or by compressing its walls. If subcutaneous, this tumor is of a blue or purple color, of an oblong shape, and will be seen to receive the dilated tortuous veins. It will be found to pulsate distinctly with a tremulous jarring motion, rather than a distinct impulse. Auscultation detects in it a loud and blowing, whiffing, rasping or hissing sound, usually of a peculiarly harsh character. This sound has very aptly been compared by Porter to the noise made by a fly in a paper-bag, and by Liston to the sound of distant and complicated machinery. The thrill and sound are more distinct in the upper than in the lower part of the limb, and are most perceptible if it be allowed to hang down so as to become congested. Besides these local symptoms, there are usually some muscular weakness, and diminution in the temperature of the part supplied by the injured artery.

Treatment.—As this condition, when once formed, is stationary, all operative interference should be avoided, an elastic bandage merely being applied. Should a case occur in which more than this is required, the artery must be cut down upon and ligatured on each side of the wound in it.

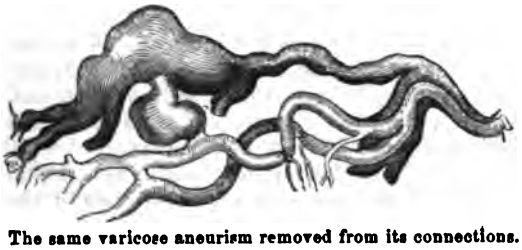
Varicose Aneurism.—In this case the openings in the artery and vein do not directly communicate (see Figs. 95 and 96), but an aneurismal sac is formed between the two vessels, into which the blood is poured before passing into the vein.

Fig. 95.

A varicose aneurism at the bend of the arm unopened.

The *pathological condition* of this form of injury consists in the formation of a circumscribed false aneurism, communicating on one side with the artery, and on the other with the vein, which is always in a state of varix. A varicose aneurism is, in fact, a circumscribed traumatic aneurism *plus* an aneurismal varix. This condition is well represented in the annexed cuts from drawings of Sir C. Bell's, in the museum of University College, representing a varicose aneurism before and after it had been opened (Figs. 95 to 98). In this case there appears to have been a high division of the brachial, and a communicating branch below the wound, between the radial and ulnar; in consequence of which, as Mr. Shaw informs

Fig. 96.

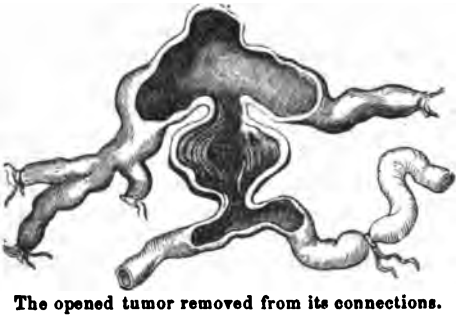


The same varicose aneurism removed from its connections.

Fig. 97.

The same tumor laid open, showing the circumscribed false aneurism between the two vessels.

Fig. 98.



The opened tumor removed from its connections. Application of ligatures.

me, the tumor pulsated as forcibly after the operation as before, and, the blood finding its way back through the aneurism into the veins, gangrene of the hand and arm was produced.

Symptoms.—In the symptoms of varicose aneurism, we have a combination of the characters of aneurismal varix, and of the circumscribed traumatic aneurism; there is a pulsating tumor, at first soft and compressible, but, after a time, assuming a more solid consistence, in consequence of the deposition of fibrine within it; above this tumor, the vein that has been punctured is dilated into a fusiform pouch, presenting the ordinary characters of varix. The sounds heard in these tumors are of two distinct kinds: there is the peculiar buzzing thrill

that always exists where there is a preternatural communication between an artery and vein; besides this, there is a blowing or bellows-sound, dependent on the aneurismal disease. These signs are most perceptible when the limb is in a dependent position; and the sounds can often be heard in the veins at a considerable distance from the seat of injury. There is also some impairment in the nutrition and temperature of the parts supplied by the injured vessels. As the disease advances, the aneurismal tumor lying between the artery and vein continues to increase in size, and to become hardened by the deposition of laminated fibrine. If left to itself, it would probably continue to enlarge until sloughing in the integuments covering it, followed by hemorrhage, took place. In some cases, the aperture of communication between the vein and sac becomes closed, and the aneurism is converted into one of the false circumscribed variety.

Treatment.—The treatment of this disease must be conducted on different principles from those that have been laid down as required in the ordinary circumscribed traumatic aneurism; the difference depending upon the fact, that in the varicose aneurism there is always a double aperture in the sac, and that thus the proper deposition of laminated fibrine necessary for its occlusion cannot take place. The sac of such an aneurism may be compared to one that has been ruptured, or accidentally opened, in which we could consequently not expect the occurrence of those changes that are necessary for the cure of aneurism by the Hunterian operation.

In a varicose aneurism, consequently, the sac must be freely incised, and the artery tied on each side of the puncture in it. This procedure may, unless the surgeon be careful, and properly understand the pathology of this disease, be attended by some difficulty (Fig. 98). After the first incision has been made through the integuments, the dilated vein will be laid open, and an aperture will be seen at the bottom of the vessel, from which arterial blood may be made to issue. If an attempt be made to find the artery immediately below this aperture, the surgeon will be disappointed, for the sac of the circumscribed aneurism intervenes between the two vessels. That this aperture leads into the sac, and not into the artery, may readily be ascertained by introducing a probe into it, which will be seen to be capable of being carried sideways, as well as upwards and downwards, to a considerable extent, and in different directions altogether out of the course of the artery. In order to expose this vessel properly, a probe-pointed bistoury must be introduced into this opening, and the sac of the false aneurism slit up to its full extent, the coagula turned out, and the puncture in the artery sought for in the bottom of the cavity that has been exposed; this may now readily be made visible by the escape of a jet of arterial blood on relaxing the pressure on the upper part of the artery; a ligature must then be passed above and below the wound, and the cavity lightly dressed with lint.

CHAPTER XIV.

WOUNDS OF SPECIAL ARTERIES.

Carotid Artery and its Branches.—Wounds of the *carotid artery*, and of its primary and secondary divisions, are of more frequent occurrence in civil practice than similar injuries of any other set of arteries in the body, in consequence of the neck being so frequently the seat of suicidal attempts. The hemorrhage from wounds of the main trunk is so copious as often to be immediately fatal. In the event of a surgeon being at hand, both ends of the bleeding vessel must be at once ligatured. Should the hemorrhage, whether primary or secondary, proceed from a deep branch, as the internal maxillary, deep temporal, or internal carotid, so situated as not to admit of the vessel being exposed and ligatured at the seat of wound, the ordinary rule of practice of tying a wounded artery at the seat of injury must be departed from, and the common carotid tied in the neck.

In consequence of the speedy fatality of the wounds of the carotid artery and its

branches, *traumatic aneurisms* are rarely met with in this situation; they do, however, occasionally occur, and the records of surgery contain at least six instances of the kind, in each of which the common carotid was tied, and the patient ultimately recovered.

Aneurismal varix of the internal jugular vein, dependent on puncture of it and of the carotid artery, usually the result of sword-thrusts in the neck, is apparently of more frequent occurrence than traumatic aneurism in this region; probably owing to the close proximity of the vein rendering it difficult for the artery to be wounded on the outer or anterior sides, without first perforating that vessel. The symptoms presented by cases of this kind, though offering the general characteristics of aneurismal varix, yet have several points that are worthy of special remark. The wound of the vessels has been in every instance followed by the effusion of a large quantity of blood into the loose cellular tissue of the neck; the extravasation acquiring even the size of a child's head, and threatening immediate suffocation. As this extravasation subsided, the ordinary characters of aneurismal varix began to manifest themselves. The period at which these symptoms first made their appearance varied somewhat in the different cases, but they always occurred within four or five days of the receipt of the injury. In none of the cases did the disease appear to shorten life, or to occasion any dangerous or inconvenient effects, with the exception of some difficulty in lying on the affected side, and occasional giddiness or noise in the head on stooping. No operation is admissible in these affections.

Varicose aneurism does not appear to have been met with in this situation.

Traumatic aneurism of the temporal artery, and of its branches, occasionally occurs as the result of partial division of these vessels in cupping on the temple; two cases of this kind I have met with, in both of which the disease was readily cured by laying the tumor open, turning out its contents, and tying the artery on each side of it.

Hemorrhage from the *deep arteries of the face*, as in gunshot injuries, if too copious to be restrained by cold, requires the ligature of the common or external carotid.

Subclavian Artery.—A wound of the subclavian artery may almost invariably be looked upon as fatal; though, in consequence of the manner in which the vessel is protected by the clavicle, this injury can scarcely occur except from gunshot violence. From the rapidly fatal nature of wounds of the subclavian artery, *traumatic aneurisms* in this situation are not met with; but where the artery passes into the axilla below the margin of the first rib, they are not of unfrequent occurrence.

Aneurismal varix of the subclavian vein, resulting from wound of the artery in this situation, has been seen, notwithstanding the separation that exists between the two vessels until they reach the acromial angle of the subclavian space. These injuries have likewise usually been the result of sword-thrusts, and do not admit of any surgical interference.

Axillary Artery.—In *open wounds of the axillary artery and of its branches*, the rule of practice consists in cutting down upon the bleeding vessel wherever it may be situated, and ligaturing it on each side of the wound. It must be borne in mind that, the arterial branches given off between the lower edge of the first rib and the fold of the axilla being very numerous, a punctured wound of the axilla or side of the chest may injure one of these vessels; though from its course, and the free flow of arterial blood that has followed the stab, it may be supposed that the axillary artery itself has been punctured. The particular vessel injured can only be ascertained by following up the wound, and ligaturing the artery that furnishes the blood.

In some cases, however, the state of the parts may be such, that it may be impossible to trace the artery at the depth at which it is situated, or even to expose it in a more superficial situation, as in the stump after amputation at the shoulder-joint. Under these circumstances, the rule of ligaturing an artery at the seat of injury may be departed from, and the main trunk should be tied either above or below the clavicle; and the success of this operation has been sufficient to justify our having recourse to it, rather than exhaust the patient by any prolonged attempts at the ligature of the vessel in the open wound, though I think that this ought first to be attempted. Of 15 cases in which the artery has been ligatured either above or below

the clavicle, for hemorrhage from wounds in the axilla or from stumps, I find that 9 were cured and 6 died. Although the success is about equal in whichever situation the vessel be tied, I should certainly give the preference to the supraclavicular operation, owing to the greater facility of its performance, and the comparative absence of collateral branches at the seat of ligature. In some cases, however, especially after amputations at the shoulder, the clavicle is pushed up at its acromial end, and then the artery might be best reached below the clavicle, under or through the pectoral muscles.

Traumatic aneurism in the axilla is not of unfrequent occurrence, arising directly from gunshot wounds, or from the thrust of a knife, sabre, or other pointed weapon. In some cases the injury arises from a subcutaneous rupture of the vessel, the patient stretching out and straining his arm in an attempt to save himself from falling, and feeling a sudden snap in the axilla, which is followed by the formation of a rapidly diffused aneurism.

There are several cases on record in which axillary aneurism has resulted from violent attempts made by the surgeon in the reduction of old standing dislocations of the head of the humerus. Thus Pelletan mentions a case of this kind, in which the tumor, being supposed to be emphysematous, was opened, and the patient perished of hemorrhage. Warren relates a case of diffused axillary aneurism resulting from rupture of the artery, in consequence of the surgeon attempting to reduce a dislocation of the humerus by using his foot as a fulcrum in the axilla, but without taking off his boot. Gibson has related three cases of axillary aneurism following rupture of the artery, in the attempt to reduce old standing dislocations with the pulleys. These cases are of much interest to the surgeon, as showing the necessity for great caution in the use of powerful extending force in the reduction of old dislocations, adhesions having probably formed between the artery and head of the bone.

Some of these traumatic axillary aneurisms have a tendency to diffuse themselves with great rapidity, filling up the whole of the hollow of the armpit, and extending under the pectorals, even up around the shoulder. In other cases, again, when more circumscribed, the disease may get well spontaneously, as happened in cases recorded by Van Swieten, Sabatier, and Hodgson. In other instances, again, the disease has remained stationary for years, or has even undergone consolidation under medical treatment. It cannot, however, be considered sound practice to leave a traumatic aneurism of this artery without surgical interference, after the ordinary dietetic and hygienic plans of treatment have failed in effecting a cure, for it may at any time become rapidly diffused, or inflame and suppurate.

The *treatment* of traumatic axillary aneurism must depend not only on the question whether it be diffused or circumscribed; but, if diffused, whether it be of recent origin, or have originated from puncture or from subcutaneous rupture or laceration of the vessel as a consequence of dislocation, fracture, blow, or strain.

When a *diffused traumatic aneurism* of recent origin, rapid formation, and dependent upon puncture of the artery, is met with in the axilla, the treatment must be conducted in the same way as that of a wounded artery, without extravasation, in this situation. As Mr. Guthrie very justly observes, it can make no difference whether the puncture in the skin have healed or not—the condition of the artery must be the same. The tumor should be laid open, the coagula turned out, the artery sought for, and ligatured where wounded. There is, however, danger after this operation, either of secondary hemorrhage coming on from the seat of wound, by blood conveyed through the collateral vessels which open into the subscapular and circumflex arteries; or else of the limb falling into a state of gangrene. In either case, amputation of the shoulder and through the aneurismal extravasation is the only practice that holds out a chance of life to the patient.

In those cases of diffused traumatic aneurism of the axilla that arise from subcutaneous rupture or laceration of the artery, the condition of parts is essentially the same as in a case of an open wound of the vessel, with the exception of the absence of any external aperture in the integuments. In these cases a tumor of considerable size, hard or fluctuating, according to the state of coagulation of its contents, will form with more or less rapidity. If it have formed very quickly, the artery being torn across, and the blood coagulating as it is effused, it will not present the ordinary aneurismal signs, but may merely resemble an ordinary extravasation; from this, however, it may be distinguished by the loss of the pulse at the wrist,

and by the œdema of the arm. If it form slowly, the blood continuing fluid, there will be the usual signs of aneurism, such as thrill, pulsation, and a gushing hot sensation. In all these cases, there is much œdema of the arm, with a tendency to inflammation, suppuration, and sloughing of the tumor and the parts amongst which it lies, with perhaps gangrene of the limb itself.

Treatment.—In such a case the choice would lie between treating the injury as that of a wounded artery by direct incision, or ligaturing the vessel above the clavicle. The ligature of the vessel above the clavicle has been done three times, with only one recovery, two of the patients dying of gangrene and secondary hemorrhage. In the successful case, secondary hemorrhage had occurred; and gangrene of the arm, which threatened, was prevented, and the patient saved, by having amputation at the shoulder-joint performed. The result, therefore, of ligature is so little promising, that few surgeons would be disposed, in the face of these facts, to repeat this operation.

The only other alternative consists in treating the ruptured artery on the same principle as a wounded one, disregarding the accidental complication of the subcutaneous accumulation of a few ounces or pounds of blood. This undoubtedly is the proper surgical principle on which to act in these cases. Its adoption has been strongly urged by Guthrie, and its advantage has been demonstrated by the success attending it in several cases in which it has been adopted by Paget, Syme, and others. The operation consists in compressing the subclavian above the clavicle, either by the direct pressure of the finger, or, as was done by Mr. Syme in his case, by previously making an incision over it, through which it could be more readily commanded; then laying the tumor open by a free incision through the anterior fold of the axilla and the pectoral muscles, turning out the coagula, and seeking for and ligaturing the artery at both ends; for it must be remembered, that the distal extremity of the torn vessel will probably bleed freely, owing to the open anastomoses round the shoulder.

Circumscribed traumatic aneurisms of the axillary artery are not uncommonly of slow formation, existing for several months or years before they require operation, although resulting from punctured wound of the armpit. In chronic cases of this kind, the aneurism is necessarily provided with a firm and distinct sac, and approaches closely in its characters to the pathological form of the disease.

The *treatment* here cannot be conducted on the principles that guide us in the management of a wound, or of a diffused aneurism of recent occurrence of this artery; for not only is the circumscribed aneurism provided with a sac, but the vessel at the point injured would very probably be found to have undergone changes that would render it little able to admit or to bear the application of the ligature. It would be softened, thickened, and lacerable, with perhaps a wide funnel-shaped aperture leading into the sac, which would be closely incorporated with the neighboring parts. But, indeed, the treatment of this form of circumscribed traumatic aneurism by the ligature of the artery on the proximal side of the sac, has been found to be attended with remarkable success. In eight recorded cases in which this operation has been performed, not one fatal result has been noted. In all, the aneurism arose from stabs or gunshot wounds, and had existed for various periods, between two weeks and four years. In four of the cases the artery was ligatured above, and in four below the clavicle; and in one case of each category there was suppuration of the sac.

The particular point at which the artery should be ligatured must depend upon the condition of the tumor. If this be of large size, or arise from the upper part of the axillary artery above or immediately below the pectoralis minor muscle, there is no choice but to deligate the vessel above the clavicle. Should, however, the principal increase in the tumor take place in a direction downwards and forwards under the great pectoral muscle, the point of the artery immediately below the clavicle appearing to be free from disease, the question would arise as to whether this part might not be selected for the application of the ligature; and as the results of both operations have hitherto been equally favorable, this must rather be determined by the peculiarities in each case than on more general grounds. Most surgeons, I think, would however prefer ligaturing the artery above the clavicle, as being a simpler proceeding than tying it below that bone; which, moreover, has the disadvantage of bringing the scalpel into very close proximity with the sac, which, were it to stretch upwards under the pectoralis minor to a greater extent than could be

discernible externally, might possibly be opened by the knife, as has even happened in operating above the clavicle. It has been recommended to apply the ligature between the sac and the origins of the subscapular and posterior circumflex arteries, above the former and below the latter; but this is an anatomical impossibility, if the aneurism be situated above the lower border of the axilla.

Compression of the artery on the distal side of the tumor succeeded in curing the disease in a case that was under Dr. Goldsmith, of Vermont.

Brachial Artery.—The hemorrhage from *wounds of the brachial artery* may sometimes be arrested by the employment of methodical compression, but usually it requires the ordinary ligature on each side of the aperture.

This vessel may occasionally be the seat of *traumatic aneurism*, in consequence of a puncture received in venesection. This accident, which was formerly of frequent occurrence when venesection was practised by professed phlebotomists, now very rarely happens. Should a surgeon be so unfortunate as to puncture the brachial artery in this way, he may prevent injurious consequences by keeping up a proper degree of pressure, by means of a graduated compress applied immediately on the occurrence of the accident. With this view, the fingers, hand, and forearm having been very carefully padded and bandaged, a well-made graduated compress should be firmly applied over the seat of puncture, and retained there for at least ten days or a fortnight. Should the aperture in the artery not be closed in this way, either a circumscribed false aneurism, a varicose aneurism, or an aneurismal varix will form, according to its situation in relation to the vein.

In the *circumscribed traumatic aneurism* at the bend of the arm, following a wound of the brachial artery, we have the usual soft or semi-solid pulsating tumor, which can readily be emptied on pressure, and possesses more or less bruit. This disease may be *treated* in one of three ways: 1, by compression upon or above the tumor; 2, by ligaturing the artery leading to it; or 3, by cutting through the sac, and deligating the vessel on each side of the aperture in it.

The compression of the tumor has often been successfully practised. It may be done by means of a graduated compress on the tumor, and the application of a ring-tourniquet over the artery: the tumor becoming consolidated, and gradually undergoing absorption. In employing compression great care must be taken, however, not to induce sloughing of the tissues over the tumor by a sudden and too forcible pressure. The limb should be carefully bandaged up and maintained in the semi-flexed position. Should this plan not succeed, we must be guided in our ulterior measures by the particular conditions of the case. If the tumor be of recent origin, soft and compressible; or, though of longer duration, large, with a thin sac, and danger of becoming diffused, it should be treated by direct incision, and the artery be deligated on each side of the wound in it. Should, however, the tumor be small, or but of moderate size, and the sac be tolerably thick and firm, so as to admit of the deposit of laminated fibrine, we may treat it by deligation of the brachial artery, either in the middle of the arm, or, as Anel did with success, immediately above the tumor. In the event, however, of the disease not being cured in this way, incision of the sac must be had recourse to, as I have known to be necessary in a case in which the brachial artery was tied above the tumor, which was large, with a thin sac, the pulsations returning in a few days, and the tumor continuing to enlarge.

Varicose aneurism, at the bend of the arm, presents the ordinary character of the disease. Occasionally, though rarely, it would appear that the aperture of communication between the aneurismal sac and the vein becomes closed, and thus the varicose is converted into the ordinary circumscribed traumatic aneurism.

The *treatment* of this affection must be conducted on different principles from that of the ordinary circumscribed variety; for whatever be the density of the sac, it is never, as has already been explained (p. 202), a perfect one, having always an opening into the vein which would prevent its proper closure by the deposit of laminated fibrine. In four cases related by Sabatier, which were treated by Anel's operation, amputation became necessary in two; and in the other cases, the operation by incision of the sac was required before a cure could be effected. The sac must therefore be laid open, and the vessel tied on each side of it in the way that has been recommended in the treatment of varicose aneurism, and with the caution there laid down. If the varicose aneurism be converted, after a few days, into the circumscribed form, the aperture into the vein becoming occluded, ligature of the

artery above the sac may be successfully employed, or compression may succeed in curing the disease.

In *aneurismal varix* of the arm, a roller and compress are all that can be required.

Arteries of the Forearm and Palm.—These vessels are very commonly wounded by pieces of glass, earthenware, or knife-cuts. In every case the bleeding point must be cut down upon, and both ends of the vessel tied. This rule is peculiarly imperative in this situation, on account of the freedom of the anastomosis through the palmar arches. In many of these cases the bleeding is at first very free, but, being arrested by pressure, does not break out again until eight or ten days have elapsed; when, the arm being much infiltrated with blood, inflamed, and swollen, double ligature of the vessel, at the seat of injury, has to be practised under somewhat difficult and unfavorable circumstances.

Traumatic aneurism of the radial and ulnar arteries usually assumes the circumscribed form, owing to the pressure employed at the time of injury confining the extravasation. If it be small and recent, and situated superficially at the lower part of the forearm, or if it be in any way diffused, the better plan is to cut down upon and through the tumor at once, ligaturing the vessel on each side. If, however, the aneurism be deeply seated amongst the mass of muscles at the upper part of the forearm, near the elbow-joint, the wound having healed, and the soft parts covering it being healthy and firm, the advice given by Mr. Liston appears to be most judicious: rather than cutting through the muscles, and detaching their connections, he recommends that the aneurism should be left to attain some consistence, and then that the brachial artery be secured in the mid-arm. In such cases as these, also, compression of the brachial, with moderate pressure on the tumor itself, has effected a cure.

Wounds of the palmar arches not unfrequently occur from the breaking of glass or china in the hand, or stabs from some pointed instrument, and are always troublesome to manage. If the surgeon see the case shortly after the infliction of the wound, he may endeavor, by enlarging the aperture to a moderate extent, and with due attention to the tendons and nerves of the part, to secure the bleeding vessel. Should he fail in doing this, which he certainly will if it be the deep arch that is injured, a graduated compress must be well and firmly applied. If this be properly done, it will very commonly be an effective means of arresting the hemorrhage. If it be loosely and ineffectually put on, it will be worse than useless. The proper mode of putting on this compress is as follows: A tourniquet having been applied on the brachial artery, the wound must be carefully cleared of all foreign bodies, wiped dry, and lightly touched with the nitrate of silver. A wooden splint is then to be put on the back of the hand and the lower part of the forearm; each finger is then to be separately and carefully bandaged, and the tails of these finger-bandages must be attached to the splint at the back of the hand. A firm well-made graduated compress is now to be placed with the apex downwards on the wound, so as to bring and press the edges together, and securely bandaged against it. The circulation through the limb should still, if possible, be controlled with a ring-tourniquet, applied on that artery above the wrist which appears most to correspond with the arch wounded, or, better still, on the brachial itself; or the elbow may be forcibly flexed, and the forearm bandaged to the arm in this position, so that the hand rests upon the shoulder. The compress and limb must be left undisturbed for at least five or six days, when, the brachial being compressed, the dressings may be taken off, and the state of the palm examined. Should the wound be healing and look well, the hand-splint and compress may be reapplied; but should the palm be sloughy and infiltrated, with a hemorrhagic tendency, it will be useless again to resort to compression, and recourse must be had to other means.

Should an ineffectual attempt have been made to arrest the primary hemorrhage, or should the case be not seen until several days have elapsed, when secondary hemorrhage has occurred, and the palm has become infiltrated and swollen, pressure can no longer be borne upon the seat of injury, and it is useless to endeavor to search for the injured vessel in the midst of sloughy and infiltrated tissues, through a narrow wound which cannot be enlarged without danger of disorganizing the hand. In these circumstances, it is necessary to deviate from the ordinary rule of practice in wounded arteries, and the Hunterian operation must be performed. The surgeon may either tie both arteries above the wrist, or at once deligate the brachial. Both methods of treatment have their advocates. I prefer the simulta-

neous ligature of the two arteries of the forearm, just above the wrist, where they are superficial and very easily reached. In several cases under my care, the radial and ulnar, immediately above the hand, have been tied at the same time with complete success, and I have never seen a case in which this operation has failed; but should it do so, or should hemorrhage occur after this, as might happen in the case of an enlarged interosseous artery, the surgeon must have recourse to compression or ligature of the brachial.

Circumscribed traumatic aneurism in the palm is by no means of frequent occurrence. It may, however, follow wounds of the palmar arches. In such a case as this, it would be clearly out of the question to lay open the sac, and to search for the injured vessel in the midst of the aponeurotic and tendinous structures of the hand. It would consequently be necessary, either to tie the radial and ulnar arteries immediately above the wrist, or to ligature the brachial in the upper arm. The latter plan should be preferred; as, were the first mode of treatment put into practice, the sac might continue to be fed by the interosseous artery, as happened in a case of Roux's, in which the patient died of hemorrhage from the palmar aneurism after the ligature of both arteries of the forearm. In the case represented (Fig. 94), Liston successfully ligatured the brachial in the mid-arm, after compression upon it had failed to effect a cure.

Femoral Artery and its Branches.—The hemorrhage from these arteries when wounded is always very profuse. In all cases, ligature of the wounded vessel at the seat of injury should be practised.

If a *diffused traumatic aneurism* have already formed, the artery should be commanded by a tourniquet, as it passes over the brim of the pelvis, the sac laid open, and the bleeding vessel sought for and tied. Guthrie has collected a great number of cases, which prove incontestably that the general principles of treatment in wounded arteries must not be departed from, when the arteries of the groin or thigh are wounded. On the contrary, the facility with which in most cases the circulation is kept up, and the readiness with which secondary hemorrhage comes on as a consequence of the free anastomoses in this situation, render the rule of practice of applying a ligature on each side of the wound in the vessel peculiarly stringent in all recent arterial wounds in this part of the body. Secondary hemorrhage and gangrene of the limb are the great sources of danger here. When gangrene is imminent, or has come on, amputation is necessarily the sole resource. With regard to secondary hemorrhage supervening after ligature of the artery *at the seat of injury*, there is, I think, no safe course but removal of the limb. Where the artery has been tied higher up, as, for instance, when the external iliac has been ligatured for recent wounds or traumatic aneurisms in the groin or upper part of the thigh, the hemorrhage appears to have returned, or gangrene to have supervened in all the cases. This fact was remarkably illustrated in the Crimean war. Thus, Dr. Macleod states that the French in one hospital at Constantinople ligatured the femoral at a distance from the wound for secondary hemorrhage seven times, and that all the cases failed.

If the traumatic aneurism have assumed a *circumscribed* character, it must be treated on the principles laid down for this form of the disease, the supplying artery being ligatured above the tumor; and cases are not wanting in proof of the success of this practice.

It occasionally, though rarely, happens that a *varicose aneurism* is formed in the groin or upper part of the thigh, as the result of wound of the artery and vein in this situation. It usually presents the ordinary characters of this disease, but some peculiarities have occasionally been met with. Thus, in a case related by Horner, there was a wavy motion in the femoral vein on the uninjured side, arising from the blood in the wounded vessel communicating a thrill upwards to that contained in the vena cava. In a case related by Dr. Morrison, it is stated that a tumor, as large as the human uterus at the third month of pregnancy, communicated with the injured vein.

The *treatment* of this disease is exceedingly unsatisfactory. Of four cases in which the external iliac artery was tied, a fatal termination occurred in every instance; two of the patients dying of gangrene of the limb, and the remaining two of secondary hemorrhage and consecutive pneumonia. It has consequently been proposed by Guthrie that the tumor be laid open, and the artery secured above and below the aperture in it. As this plan has never been fairly put into practice, it

would perhaps be useless to speculate on the chances of success likely to attend it; yet we must bear in mind, that laying open an aneurism of this kind in the groin is a very different matter from adopting the same procedure at the bend of the arm, or in a situation where the surgeon can readily command the artery on the proximal side of the sac. The gush of blood from so large an artery as the common femoral would be so great that, with whatever rapidity the operation were performed, there would be considerable risk of the patient suffering a fatal hemorrhage, before the vessel, matted and incorporated as it would be with surrounding parts, could be separated and secured; and the ligature of the vessel would probably be followed by gangrene of the limb.

Recent wounds and traumatic aneurisms of a diffused kind, connected with the *arteries of the leg and foot*, require to be treated by the free exposure of the bleeding orifice in the vessel, and its inclusion between two ligatures. In doing this, if the wound be situated in the posterior tibial or peroneal artery, the surgeon will have to cut freely by the side of or through the muscles of the calf. This he must do in the direction of their fibres, injuring them by transverse incision as little as possible; and, by taking the track of the wound as his guide, the bleeding vessel will at last be reached, and must then be tied in the usual way. Such an operation practised on a person with a muscular limb that is infiltrated with blood and inflammatory effusions, is in the highest degree difficult; and, deterred by these difficulties, surgeons have often attempted to arrest the hemorrhage by the ligature of the superficial femoral or popliteal arteries. The French more particularly adopt Anel's operation in such cases, usually ligaturing the popliteal; and though this practice has occasionally been successful, as happened in a case in which I saw the popliteal ligatured for consecutive hemorrhage from a wound of the posterior tibial artery, by my respected master, Samuel Cooper, and in another instance in which Dupuytren successfully ligatured the femoral for a diffused traumatic aneurism of the posterior tibial, from wound with a pistol ball, yet I fully concur with Mr. Guthrie in deprecating it as contrary to good surgery, and, with him, regard the success that has occasionally followed these operations as purely accidental. In secondary hemorrhage from the deep arteries of the leg, compression of the superficial femoral should be tried, the limb being at the same time bandaged and elevated. Should these means fail in arresting the bleeding, no more time must be lost, and the surgeon should never hesitate to amputate the patient's limb. In no other way do I believe that the patient has a fair prospect of safety.

Small *circumscribed aneurisms* are occasionally met with in the foot, in consequence of the wound of one of the plantar arteries, as in operations for club-foot. If pressure have failed in preventing or curing the disease, the only course left to the surgeon is to lay the tumor open, and to ligature the artery on each side in the usual way.

Gluteal Artery.—*Traumatic aneurisms of the gluteal artery* are of less frequent occurrence than might *à priori* have been imagined from the situation of the vessel exposing it to injury. These aneurisms may acquire an enormous size. In John Bell's celebrated case, the tumor is said to have been of "prodigious size," and to have contained eight pounds of blood. In Mr. Syme's case the tumor was as large as a man's head at the base, occupied the whole hip, and rose into a blunt cone.

[Acupressure has been particularly recommended in cases of secondary hemorrhage from wounded arteries. It would appear to be especially adapted to cases of wounds of the palmar arches, and is, in other instances, occasionally preferable to the ligature on account of the greater rapidity with which it can be applied: thus, in one case I was able to prevent immediate death from hemorrhage, by acupressing the femoral artery at the fold of the groin. (*Trans. Coll. Phys.*, in *Am. Journ. Med. Sciences* for July, 1868, p. 134.)—A.]

CHAPTER XV.

ENTRANCE OF AIR INTO VEINS.

THE entrance of air into a wounded vein, though an accident of rare occurrence, is one that occasions such peculiar and alarming symptoms, that it becomes necessary to be acquainted with the circumstances attending it; and its study is the more interesting to the practical surgeon, as it is chiefly in the course of operations that this condition occurs.

In surgical practice, we meet only with *spontaneous admission* of air into the circulation. This was first observed in the year 1818, in a case in which the internal jugular vein was opened during the removal of a large tumor from the right shoulder by M. Beauchesne. The investigation of this subject is consequently a comparatively recent matter, in which the labors of the Commissioners of the French Academy are conspicuous, and the names of Magendie, Amussat, Cormack, and Wattmann, are distinguished.

Results of Experiments on Animals.—As cases of the entry of air into the veins comparatively seldom occur in man, it is necessary to study the phenomena accompanying it on the lower animals. It has long been known to physiologists that the forcible introduction of air into the circulation would kill an animal; and Morgagni, Valsalva, Bichat, and Nysten, have made this a subject of observation and experiment. The death of the animal in these cases appears to be dependent partly on the quantity of air injected, and partly on the rapidity with which it is thrown in. Bichat supposed that a single bubble injected into the circulation killed the animal with the rapidity of lightning; but this is erroneous, as shown by Nysten. I have on several occasions injected two or three cubic inches of air into the jugular vein of a dog, without producing death, though much distress resulted. The rapidity with which the air is thrown in exercises a considerable influence upon the result. If blown in quickly a small quantity may kill; if thrown in slowly and gradually, a large quantity may be injected without destroying life, the blood appearing to dissolve and carry away the gaseous fluid. In experiments which I have made on the subject, I have observed the following phenomena in cases where death was produced.

On exposing the internal jugular vein low in the neck, and puncturing it at a place where the flux and reflux of the blood are plainly discernible, there is perceived in the first inspiratory effort made by the animal after the wound, a peculiar lapping or gurgling liquid, hissing sound; the nature of the sound depending partly on the size and the situation of the opening in the vessel. At the same time, a few bubbles of air are seen to be mixed with blood at the orifice in the vein. The entrance of the air is immediately followed by a struggle during the deeper inspirations, in which fresh quantities of air gain admittance, the entrance of each portion being attended by the peculiar sound above described. On listening now to the action of the heart, a loud churning noise will be heard, synchronous with the ventricular systole; and the hand will, if applied to the parietes of the chest, perceive at the same time a peculiar bubbling, thrilling, or rasping sensation, occasioned by the air and blood being, as it were, whipped together between the columnæ carneæ and chordæ tendineæ. As the introduction of air continues, the circulation becomes gradually more feeble and languid; the heart's action, however, being fully as forcible as natural, if not more so. The animal soon becomes unable to stand; if placed upon its feet, it rolls over on one side, utters a few plaintive cries, is convulsed, extrudes the feces and urine, and dies. If the thorax be immediately opened, it will be seen that the heart's action is continuing regularly and forcibly, and that the pulmonic cavities, though filled, do not appear distended beyond their ordinary size.

Death occurs, as I have shown in a paper on this subject, published in the 158th number of the *Edinburgh Medical and Surgical Journal*, in consequence of the air

and blood being beaten up together in the right cavities of the heart into a spumous froth, which cannot be propelled through the pulmonary vessels; hence there is a deficient supply of blood to the brain and nervous centres, and fatal syncope comes on, attended usually by convulsions.

Spontaneous entry of air into the veins of man is attended by two distinct sets of phenomena, one of a local, the other of a constitutional character.

Local Phenomena.—These consist in a peculiar sound, produced by the entrance of the air, and in the appearance of bubbles about the wound in the vein. The sound is of a hissing, sucking, gurgling, or lapping character, and never fails to indicate the dangerous accident that has occurred. When once heard, whether in man or the lower animals, it can never be mistaken. It has fortunately fallen to my lot to hear this sound in the human subject on one occasion only—that of a patient who had attempted suicide by cutting his throat. The internal jugular being wounded, was being raised for the purpose of having a ligature passed under it; at this moment a loud hissing and gurgling sound was heard, some bubbles of air appeared about the wound, the patient became faint, and greatly oppressed in his breathing. The ligature was immediately tightened, the faintness gradually passed off, and no bad consequences ensued.

The *constitutional effects* are usually very marked. At the moment of the entry of the air, the patient is seized with extreme faintness, and a sudden oppression about the chest; he usually screams out or exclaims that he is dead or dying, and continues moaning and whining; the pulse becomes nearly imperceptible, and the heart's action laboring, rapid, and feeble; death commonly results, but not instantaneously, in many cases at least. Thus Beauchesne's patient lived a quarter of an hour after the occurrence of the accident; Mirault's between three and four hours; and Clemot's several hours. Amongst the other recorded fatal cases, I have not been able to find any but vague statements as to the length of time during which the patients survived.

If the patient survive the immediate effects of the accident, he may probably recover without any bad symptoms, as happened in the case to which I have referred as occurring at the University College Hospital, and in an instance recorded by B. Cooper. The presence of the air in the pulmonic capillaries would appear in some cases to act as an irritant, and to induce fatal pneumonia or bronchitis, as happened to the patients of Roux and Malgaigne.

Cause.—The cause of the spontaneous entry of air into the veins has been very completely investigated and determined by the French Commission. If we open a large vein at the root of a dog's neck, near the thorax, in which the venous pulse, or flux and reflux of the blood is perceptible, we shall see that air rushes in at each inspiration—but only at this time—never gaining entry during expiration. This is owing to the tendency to the formation of a vacuum within the thorax, more particularly in the pericardium, during inspiration. This suction action, or "venous inspiration," is confined to the large vessels in and near the thoracic cavity, being limited by the collapse of the coats of the veins at a little distance from this. If the veins were rigid tubes, it would extend throughout the body; but as they are not, it ceases where the coats collapse. It is, indeed, limited to that part of the root of the neck and the axilla where the venous flux and reflux are perceptible; and the space in which it occurs has been termed the "dangerous region." But, in certain circumstances, air may spontaneously gain admission at points beyond this.

It is well known that what is called by the French writers the "canalization" of a vein, or its conversion into a rigid uncollapsing tube, is the condition which is most favorable to the introduction of air into it. Indeed, except in those situations in which there is a natural movement of flux and reflux of the blood in the veins, this accident cannot occur unless these vessels be canalized, or, in other words, prevented from collapsing. This canalization of the vessel may be occasioned in a variety of ways. Either the cut vein may be surrounded by indurated areolar tissue, which will not allow it to retract upon itself, but keeps it open like the hepatic veins; or the coats of the vessel may have acquired, as a consequence of inflammation or hypertrophy, such a degree of thickness as to prevent their falling together when divided. Then, again, the principal veins at the root of the neck have, as Bérard has pointed out, such intimate connections with the neighboring aponeurotic structures, that they are constantly kept in a state of tension, so that their sides are held apart when they are cut across. The contractions of the pla-

tysma and other muscles of the neck may likewise, as Sir C. Bell has shown, have a similar effect. In removing a tumor, also, that is situated about the neck, the traction exercised upon its pedicle may, if this contain a vein, cause it to become temporarily canalized; and the incomplete section of the vessel, especially in a transverse direction, must prevent the approximation of the sides of the incision in it, which will be rendered open and gaping by the retraction of the surrounding tissues. This patency in the incision in the vein is apt to be increased by the position that is necessarily given to the head and arm, in all operations of any magnitude about the shoulders and neck. Lastly, the introduction of air into a vein will be favored by the vessel being divided in the angle of a wound, the vein being, when the flaps that form that angle are lifted up, rendered open-mouthed and gaping.

On looking over the reports of cases in which air gained admittance into the veins during operations, it will be found that these vessels were always in one or other of the above-mentioned conditions. Thus, in Beauchesne's case, air was introduced in consequence of incomplete division of the external jugular, immediately above the right subclavian, whilst in a state of tension, during the removal of a portion of the clavicle. In a case that occurred to Dupuytren, a large vein connected with a tumor, and communicating with the jugular, was cut at the last stroke of the scalpel, whilst the tumor was being forcibly drawn up. The vein was found to be adherent to the sides of a sulcus, so that it remained gaping when cut. In a case related by Delpech, there was hypertrophy of the axillary vein, causing it to gape like an artery. In Castara's case there was incomplete section of a vein which opened into the subscapular, whilst the tumor was being raised up. In Roux's case a vein in the neck was opened, whilst a tumor, which was being removed from that region, was being forcibly raised in order to dissect under it. Ulrick saw the accident occur in consequence of the incomplete division of the internal jugular vein, which was implicated in a tumor in the neck. A similar case happened to Mirault of Angers, the internal jugular being divided to half its extent. A case occurred to Warren, in which the air entered by the subscapular vein, the coats of which were healthy, but in a state of tension in consequence of the position of the arm; and another, in which the same accident happened from the division of a small transverse branch of communication between the external and internal jugular, whilst in a state of tension. Mott, whilst removing a tumor of the parotid gland, opened the facial vein, which was in a state of tension in consequence of the position of the patient's head, when air was introduced. A case is related by Malgaigne in which this accident happened in consequence of the incomplete section of the external jugular vein, which was enveloped in a tumor that was being removed. M. Bégin also relates a case in which the accident happened, in consequence of the puncture of the internal jugular whilst he was removing a tumor from the neck.

These cases, which are all that I have been able to meet with in which the condition of the wounded vein was particularized, show clearly what is the state of the vessel and of the surrounding parts that is most likely to favor the occurrence of the accident, and consequently what the surgeon should particularly guard against in the removal of tumors about the neck and shoulders, viz., incomplete division of the veins, and the employment of forcible traction on the diseased mass at the moment of using the scalpel. In removing tumors from the neck and shoulder, it is in many cases impossible to avoid drawing them forcibly upwards or forwards, in order to get at their deeper attachments; but if this be necessary, the chest should, for reasons that will immediately be pointed out, be tightly compressed, so that no deep inspirations may be made at the moment that the knife is being used, or before a divided or wounded vein can be effectually secured.

Preventive Treatment.—When a patient is under the knife, the respirations are generally shallow and restrained, the breath being held, whilst every now and then there is a deep gasping inspiration; at which moment, if a vein be opened in which the pulse is perceptible, or which is canalized, air must necessarily be sucked in; and, as has already been said, in quantity and force proportioned to the depth of the inspiration. This, then, being the case, the mode of guarding against the introduction of air into the veins is obvious. The chest and abdomen should be so tightly bandaged with broad flannel rollers or laced napkins, as to prevent the deep gasping inspirations, and to keep the breathing as shallow as possible, consistently with the comfort of the patient. I have often found that the entrance of air into the veins of a dog could be arrested by forcibly compressing the chest of the animal,

so as to confine the respiratory movements; but that, as soon as a deep inspiratory effort was made, the compression having been removed, a rush of air took place into the vessel. If, therefore, during an operation about the root of the neck or summit of the thorax, the chest be bandaged, as here recommended, the surgeon must be careful not to remove the compression until the operation is completed, and the wound dressed; for, if this precaution be not attended to, the patient will most probably, on the bandage being loosened, make a deep inspiration, and the air may be sucked in at the very moment when all appears safe.

Curative Treatment.—Different plans have been recommended by surgeons for the treatment of those cases in which air has already gained admittance into a vein; but, from the very fatal nature of this accident, it does not appear that much benefit has resulted from any of them: the recovery of the patient, in some of the cases, appearing to be rather due to the quantity of air that was introduced being insufficient to cause death, than to any effort on the part of the surgeon. The two principal modes of treatment that have been recommended, consist in the *suction of the air from the right auricle*, and the employment of *compression of the chest*. Thus, Amussat and Blandin advise us to introduce the pipe of a syringe, a female catheter, or a flexible tube, into the wounded vein, if it be large enough to admit the instrument; and if not, to open the right jugular, and pass it down into the auricle, and then to employ suction, so as to empty the heart of the mixture of blood and air. At the same time that this is being done, we are, say they, to compress the chest as forcibly as possible, so as to squeeze more of the air out of the heart. Magendie and Rochoux advise suction alone; and Gerdy recommends us to be content with compression of the chest. Warren, of Boston, directs us to have recourse to *bleeding in the temporal artery*, to *tracheotomy*, or to *stimulants*, according to the condition of the patient.

The indications that present themselves in the treatment appear to me to be threefold:—

1. To keep up a due supply of blood to the brain.
2. To maintain the powers of the heart until the obstruction in the pulmonic capillaries can be overcome or removed.
3. To remove, if possible, the obstruction in the capillaries of the lungs.

We shall now see how far the means already mentioned, viz., suction, compression, &c., can fulfil these indications.

Suction would no doubt be highly advantageous if we could, by this or any other means, remove the air that has gained access to the heart, and thus prevent the pulmonic capillaries from being still farther obstructed. But, putting out of consideration the difficulty of finding the wounded vein; the still greater difficulty of introducing a suitable tube a sufficient distance into it; the danger of allowing the ingress of a fresh quantity of air, whilst opening the sides of the incision in the vein so as to introduce the tube; and the risk there would be, if the patient recovered from the effects of the accident, of having phlebitis induced; putting aside all these circumstances, which appear to me to be most serious objections, it becomes a question, according to Amussat, who is one of the strongest advocates of this mode of practice, whether, by suction with a syringe, or even by the mouth, any material quantity of air can be removed. He says that, even when the tube is introduced into the right auricle, much more blood than air is constantly withdrawn. These considerations, then, should, I think, make the surgeon hesitate before having recourse to such a hazardous mode of procedure.

The next plan, that of *circular compression of the chest*, however valuable it may be in preventing the ingress of air, can, when that fluid has once been introduced into the veins, have no effect in removing it from the circulatory system. We cannot, by any compression that we may employ, squeeze the air out of the heart. But compression may not only be productive of no positive good, but may even occasion much mischief, by embarrassing still farther the already weakened respiratory movements, and thus interfering with the due aëration of the small quantity of blood that may yet be traversing the lungs.

Bleeding from the temporal artery can by no possibility be productive of any but an injurious effect, by diminishing the already too small quantity of blood in the arterial system. *Opening the right jugular vein* may, perhaps, to a certain extent, be serviceable, by unloading the right cavities of the heart, as Dr. John Reid has shown it to be capable of doing; and it has been recommended by Dr. Cormack on

this account. Lastly, *tracheotomy* cannot be of any particular service, as the arrest of the respiratory function is secondary and not primary.

1. What, then, are the measures that a surgeon should adopt in order to prevent the occurrence of a fatal termination in those cases in which air has been accidentally introduced into the veins during an operation? Beyond a doubt, the first thing to be done is to *prevent the further ingress of air*, by compressing the wounded vein with the finger, and, if practicable, securing it by a ligature. At all events, compression with the finger should never be omitted; as it has been shown by Nysten, Amussat, Magendie, and others, that it is only when the air that is introduced exceeds a certain quantity, that death ensues. All further entry of air having been thus prevented, our next object should be to *keep up a good supply of blood to the brain and nervous centres*, and thus maintain the integrity of their actions. The most efficient means of accomplishing this would probably be the plan recommended by Mercier; who, believing that death ensues in these cases, as in prolonged syncope, from a deficient supply of blood to the brain, recommends us to employ compression of the aorta and axillary arteries, so as to divert the whole of the blood that may be circulating in the arterial system to the encephalon. This appears to me to be a very valuable piece of advice, and to be the most effectual way of carrying out the indication. The patient should, at the same time that the compression is being exercised on his axillary arteries and aorta, or, if it be preferred, as more convenient and easier than the last, on his femorals, be placed in a recumbent position as in ordinary fainting, so as to facilitate the afflux of blood to the head. The compression of the axillary and femoral arteries may readily be made by the fingers of two of the assistants who are present at every operation.

2. For the fulfilment of the second indication, that of *maintaining the action of the heart* until the obstruction in the capillaries of the lungs can be overcome or removed, artificial respiration should be resorted to as the most effectual means of keeping up the action of that organ. For the purpose of keeping up artificial respiration, the Humane Society's bellows, if they be at hand, might be used; or, if they cannot readily be procured, the surgeon must inflate with his mouth. Before inflating the lungs, it will be necessary to remove everything that can compress the chest, or interfere in any way with the free exercise of the respiratory movements. Friction with the hand over the præcordial region, and the stimulus of ammonia to the nostrils, may at the same time be resorted to.

3. The third indication—that of *overcoming the obstruction in the pulmonic capillaries*—would probably be the best fulfilled by the means adopted for the accomplishment of the second, viz., artificial inflation of the lungs. That the action of respiration, if kept up sufficiently long, will enable the capillaries of the lungs to get rid of the air contained in them, appears to be the case; for I have several times observed that, if a certain quantity of air be spontaneously introduced into the jugular vein of a dog, and artificial respiration be then established, and be maintained for half or three-quarters of an hour, a very small quantity indeed, if any, will be found, on killing the animal, in the cavities of the heart, or in the branches of the pulmonary vessels. I am aware that this is not altogether conclusive of the fact, as the air might be dissolved in the blood, or might still exist in the capillaries of the lungs, although none might be found in the larger branches of the pulmonary artery; but still it seems to me that we can hardly account for the large quantity of air that will disappear when artificial respiration is kept up, in any other way than that some, if not all of it, passes out of the capillary vessels into the air-cells of the lungs.

CHAPTER XVI.

INJURIES OF NERVES, MUSCLES, AND TENDONS.

INJURIES OF NERVES.

Contusion.—Nerves are often contused; the injury producing a tingling sensation at their extremities, and pain at the part struck. These effects usually pass off in the course of a few minutes or hours; but, in certain conditions of the system, more especially in the hysterical temperament, they may last for a considerable period, and even give rise to neuralgia of a very permanent character. In other cases the continuance of the symptoms appear to be less owing to constitutional than to local causes; apparently being due to thickening of the neurilemma, causing compression of the nerve, and thus producing a species of neuralgic paralysis of the parts supplied by it, which may become a source of nervous irritation, leading eventually to disease of the brain or spinal cord.

Puncture.—If a nerve be punctured, unpleasant consequences sometimes result, more especially in delicate women. Not only does it happen in such subjects, that the part below the puncture becomes the seat of various tingling, shooting, and burning pains, but the neuralgic condition appears to travel upwards along the proximal part of the nervous trunk. Thus, I have more than once seen a puncture of one of the digital branches of the ulnar nerve produce a kind of painful paralysis of its trunk, rendering the arm nearly useless. I have seen the same effects occur in the median nerve, from so slight a cause as the puncture of the finger by a needle, It occasionally happens in venesection at the bend of the arm, that a branch of the internal cutaneous nerve is pricked with the lancet, and that very persistent neuralgia occurs in consequence.

Division.—When a nerve is completely cut across, immediate paralysis of sensation and motion occurs in all the parts supplied by it. Consequently, if the integrity of the nerve be essential to life, as of the pneumogastric, death must ensue. When the nerve is partially divided, or bruised as well as severed, as in cases of gunshot injury, neuralgia in the parts supplied by it, and sometimes up the proximal end, is associated with the paralytic symptoms. The patient complains of numbness or deadness in the part supplied by it, and all tactile sensibility is lost; but various anomalous painful sensations of a burning, trickling, tingling, or creeping kind are complained of. These sensations usually give the idea of increased heat of the part to the patient, and are compared by him to the effect that would be produced by molten lead or boiling water running through it. But the sensation of heat is deceptive, for the part will be found on examination to be actually colder than natural. Thus I found in a woman who was under my care for a wound of the forearm, by which the ulnar nerve had been divided, that, twenty-one days after the injury, the temperature between the ring and the little finger of the injured side was 9° Fahr. below that of the same spot in the opposite hand.

The *secondary effects* of division of a nerve consist in various modifications of sensibility, not only in the parts supplied by it, but also in some cases, as in the instance of puncture, in the proximal part of the trunk of the injured nerve above the seat of its division. These effects, consisting of neuralgic pains and sensations of all kinds, and of varying degrees of intensity, from creeping and tingling up to real tic, are always associated with more or less paralysis, and are doubtless due in a great measure to the compression of the injured part of the nerve by inflammatory infiltrations, and the condensation of its sheath by plastic deposits. Besides these effects, the nutrition of the part supplied by the injured nerve becomes seriously modified. The part becomes congested, bluish, œdematous, and colder than natural. The skin peels, and becomes rough, or the seat of vesicular or bullous eruptions,

which are apt to degenerate into sluggish and unhealthy ulcers. The muscles become flabby and wasted; and ultimately deformity of various kinds may ensue from the disturbance of the proper balance of antagonism between the different sets of muscles of the part.

As union gradually takes place between the opposite ends of the divided nerve, the various phenomena that have just been described gradually subside, and complete restoration of the normal sensibility, mobility, and nutrition of the part eventually takes place. In some important cases, however, this does not happen, and, the nerve about the seat of its division becoming implicated in a mass of dense cicatricial tissues, a traumatic neuroma is developed, which, just as in similar conditions in stumps, may become the seat and the source of the most intense sufferings—the neuralgic pains darting like electrical shocks downwards to the terminal branches, and upwards along the trunk and the secondary divisions of the affected nerve.

Repair.—If a cut nerve be examined shortly after the injury, it will be found to have become slightly bulbous at the extremity, nervous matter having escaped from the neurilemma, and fibrine being thrown out around and between the two ends. Restoration of the continuity of the nerve evidently takes place, as is shown by the fact, that in the course of a few months its functions gradually become re-established in its lower part, the paralysis slowly disappearing. If, however, a portion of the nerve have been actually excised, there is no restoration of function, as was shown long ago by Haighton. Schwann and Hasse have found the return of sensibility and motion in the lower part of the nerve to be owing to nerve-tubes forming in the uniting medium, and thus serving to establish the continuity of the nerve.

In the *treatment* of a cut nerve, little can be done except to lessen the sufferings of the patient; if a sensation of heat is complained of, by the application of cold; if the part be too cold, by stimulating embrocations and frictions. The neuralgia resulting from the implication and compression of a nerve by condensed cicatricial tissue has been relieved by Warren, who has dissected the nerve out of the midst of this, without dividing or otherwise injuring it.

[Drs. S. W. Mitchell, Morehouse, and Keen, of this city, have made a special study of nerve injuries: they recommend for the ordinary pain of nerve wounds, leeching and hypodermic injections of morphia; for the *burning* pain, which is one of the most distressing symptoms of nerve lesions, repeated blistering; and for the secondary condition of the muscles, repeated faradization with the electro-magnetic battery, shampooing, and alternate hot and cold douches. Besides the direct effects of a nerve injury, very curious reflex phenomena are occasionally observed: thus I have recently met with a case of well-marked though evanescent *left* hemiplegia, from laceration of the *right* arm, requiring amputation at the shoulder-joint; the case proved fatal, and no central lesion could be detected at the autopsy. The subject of reflex paralysis has been specially studied by Dr. Mitchell, of this city, and by Dr. Echeverria, of New York.—A.]

INJURIES OF MUSCLES AND TENDONS.

Sprains or strains of muscular parts, without rupture of fibre, are of very common occurrence, especially about the shoulders, hip, and loins, and are accompanied by much pain, stiffness, and inability to move the part. When they occur in rheumatic subjects, these injuries not uncommonly give rise to severe and persistent symptoms; in some cases painful atrophy, rigidity or local paralysis of the injured muscle being induced.

In the *treatment* of these accidents, when recent, it will be found that kneading or rubbing the part with a stimulating embrocation, the application of dry cupping, or, if the pain be severe, the abstraction of a few ounces of blood by cupping, together with rest, is most efficient. If the injury occur in a rheumatic constitution it will be found useful to give colchicum and Dover's power in the following form: ℞. Extracti colchici acetici, gr. j; Pulv. ipecacuanhæ comp., gr. x; Extracti colocynthidis comp., gr. iv; fiant pil. iij. If the pain continue, the application of the "thermic hammer" is exceedingly serviceable; and if local paralysis or atrophy ensue, the use of the electro-magnetic apparatus will be beneficial.

Rupture and Division.—Subcutaneous rupture of muscles and tendons not unfrequently occurs, not so much from any external violence, as from the contrac-

tion of the muscle rupturing its own substance. The rupture may occur at one of four points: in the muscular substance itself; at the line of junction between the muscle and tendon; through the tendon; and, lastly, at the point of insertion of the muscle or tendon into bone. Sedillot found that, in twenty-one cases, the rupture occurred at the point of origin of the tendon from the muscle thirteen times; and in the remaining eight, the muscle itself was torn. It occasionally happens that the muscular sheath is ruptured, so that the belly of the muscle forms a kind of hernial protrusion through the aperture; or the tendon may be displaced by rupture of its sheath. This usually happens with the long head of the biceps, or the extensor tendons of the fingers.

These ruptures most commonly occur in middle-aged people, who have lost the elasticity of youth, though their physical strength be unimpaired. At the moment of the rupture taking place, the patient usually experiences a sudden shock, as if he had received a blow, and sometimes hears a snap. He becomes unable to use the injured limb, and at the part where the rupture has occurred finds a hollow or pit, produced by the retraction of the end of the torn muscle, which is contracted into a hard lump above this.

These accidents, though troublesome, are seldom serious. The tendo Achillis, the quadriceps extensor of the thigh, the triceps of the arm, the biceps, the deltoid, the rectus abdominis, are the tendons and muscles that most commonly give way, with the relative frequency of the order in which they are placed.

Muscles and tendons may be cut across accidentally or purposely in almost any part of the body. In these injuries there is always a considerable amount of gaping of the wound, owing to the retraction of both ends, if a muscle be divided, and of the upper end only, if a muscle be separated from its tendon or the tendon cut across.

Union.—The mode of union of these injuries has been well described by Paget. When a tendon is cut or torn across, an ill-defined mass of nucleated blastema of a grayish-pink tint is effused into the areolar tissue and sheath, between the cut ends. About the fourth or fifth day this has become more defined, forming a distinct cord-like uniting mass between the ends of the tendon; in the course of two or three more days, this mass has become tough and filamentous; the tissue gradually perfects itself, until it closely resembles tendinous structure, though for some time it remains dull white and more cicatricial in appearance. The strength of this bond of union is marvellously great; Paget found that the tendo Achillis of a rabbit, six days after its division, required a weight of twenty pounds to rupture it. In ten days the breaking weight was fifty-six pounds. Divided muscles unite in the same way as tendons, but less quickly, and by a fibrous bond.

Treatment.—The principle of treatment in these cases is extremely simple: it consists in relaxing the muscles by position, so as to approximate the divided ends; and in maintaining the limb in this position for a sufficient length of time for proper union to take place. If muscular relaxation be not attended to, the uniting bond will be elongated and weak, and perhaps altogether inefficient. Stiffness and weakness are often left for a length of time—for many months, indeed—after union has taken place; very commonly, owing to the consolidation of the divided tendon to its sheath, and that to the neighboring soft structures. Warm sea-water douches, followed by methodical friction, will greatly tend to restore the suppleness of the parts.

When the tendo Achillis is ruptured, the best mode of treatment consists in the application of an apparatus formed of a dog-collar placed round the thigh above the knee, from which a cord is attached to a loop in the back of a slipper; by shortening this cord, the leg is bent on the thigh, and the foot extended, so that the muscles of the calf become completely relaxed. After this simple apparatus has been used for two or three weeks the patient may be allowed to go about, wearing a high-heeled shoe for some weeks longer.

When partial rupture of one of the extensor muscles of the thigh takes place, the patient's limb must be kept for some little time in the same position as for fractured patella; and then he may be allowed to walk about with a leather splint behind the knee, so as to prevent flexion of this joint.

In ruptures of the muscles or tendons of the arm, a sling is all the apparatus required; but when these injuries occur to the deltoid, atony and atrophy are especially apt to result.

In division of the extensor tendons of the fingers—a very common accident—the hand must be kept extended in a straight splint for some weeks, until perfect union has taken place.

CHAPTER XVII.

INJURIES OF BONES AND JOINTS.

INJURIES OF BONES.

A BONE may be bruised, bent, or fractured.

Bruising of the Bone and Periosteum often occurs, and is usually of no great moment; but if severe, or happening in bad constitutions or in old people, it may give rise to serious consequences.

A moderate contusion of a bone that is but thinly covered, as the shin, or elbow, may give rise to troublesome symptoms from inflammation of the periosteum. If the contusion be severe, the vitality of a layer, or even of the whole substance of the bone, may be destroyed, as happens sometimes from the graze or contusion of a bullet, or the bone may become deeply inflamed and suppuration take place in its cancellous structure. In old people, the contusion of a bone is frequently followed by its atrophy and shortening, as happens in the neck of the femur; in strumous constitutions, serious disease of the bone, leading to its complete disorganization, may be attributed to this cause.

In the *treatment* of bruised bone, leeches and fomentations are the most important means that we possess; the consequences will be considered when we come to speak of necrosis.

Bending of Bone may occur in two conditions, viz.: with or without fracture. Independently of fracture, it is most commonly met with in very young subjects, before the completion of ossification; the bone being healthy, but naturally soft, at this period of life. It occasionally takes place after the adult age, but is then the result of some structural change, by which the natural firmness of the osseous tissue is diminished. The bending most commonly occurs in the long bones, especially the clavicle, the radius, and the femur, but sometimes is met with in the flat bones, or those of the skull, in which depression takes place from a blow without fracture having occurred. In many cases of bending both of long and of flat bones, there is partial fracture on the convex side.

The *treatment* is simple: the surgeon gradually straightens the bone, by applying a splint on its concave side, towards which the bone is pressed by a bandage and a pad applied upon its greatest convexity.

Fractures will be described in the following two chapters.

INJURIES OF JOINTS.

Contusions.—Joints are often *contused* by kicks, falls, or blows, so as to be severely injured, with much pain and consecutive inflammation of the capsule, synovial membrane, or other structures entering into their formation. The treatment should be actively antiphlogistic, with complete rest of the part. In a later stage, an elastic bandage, cold douches, and friction, are useful.

In some cases the *bursa*, situated in the neighborhood of a joint, is seriously bruised, and becomes inflamed in consequence; often giving rise to troublesome suppuration and some sloughing. When this takes place, free incision into the inflamed part, in addition to the ordinary antiphlogistic treatment, will afford speedy and effectual relief to the patient.

Sprains.—When a joint is twisted violently so that its ligaments are either much stretched or partially torn, though there be no displacement of the osseous surfaces, it is said to be *sprained*. These injuries are exceedingly painful and troublesome in their consequences. They most frequently occur to the wrists and ankle-joints. The

pain attending them is very severe, and often of a sickening character, and the sprain is rapidly followed by swelling and inflammation of the joint and investing tissues, often very chronic and tedious. As the inflammation subsides, stiffness and pain in using the part continue for a considerable length of time, which, in some cases, give way to a kind of rigidity and wasting of the limb. In individuals of a rheumatic or gouty habit of body, the inflammation set up in the joint as a consequence of the strain is often of a most tedious and chronic character, and will only yield to appropriate constitutional treatment; and occasionally it happens that in strumous subjects destructive disease of the joint is induced.

Treatment.—If the sprain be slight, rubbing the part with a stimulating embrocation, and giving it the support of a bandage, are all that need be done. But if it be at all severe, more active measures must be had recourse to. These must vary according to the condition of the joint when the surgeon sees the patient; but they are all conducted on the principles of securing perfect rest, and subduing inflammatory action. If the surgeon see the patient immediately on the occurrence of the accident, or before swelling to any great extent has occurred, the best method of treatment is to strap up the joint very firmly with long strips of plaster, over which a starched bandage may be applied. This method of treatment, which comprises rest, perfect immobility, and compression of the joint, puts it into the best possible condition for the repair of the injured articular structures, and for the prevention of consecutive inflammation. Should inflammation with much swelling have set in, this must be subdued by keeping the joint for several hours in cold water, or well moistened with an evaporating lotion, or wet by means of irrigation. Should this not check the inflammation, leeches may be freely applied; and, when the swelling has somewhat subsided, the joint should be supported with an elastic roller and plasters, a starched bandage, or leather splints. In the more advanced stages, when pain and stiffness alone are left, it should be well douched with cold water twice a day, and afterwards rubbed or kneaded with soap-liniment, until its usual strength and mobility are restored. This, however, very commonly does not occur in sprains of the knee and ankle for many weeks; a degree of stiffness, combined with inflammation, being left until the stretched and lacerated ligaments have regained their normal condition.

Wounds of Joints.—A joint is known to be wounded when synovia escapes from the aperture, or when the interior of the articulation is exposed. If there be any doubt as to the wound penetrating the synovial membrane, no means, by probing or otherwise, should be taken to ascertain this, as in this way the very occurrence that is to be dreaded may be induced by the surgeon. The question of the wound having penetrated into the interior of the joint will speedily be cleared up by the symptoms that supervene.

Symptoms and Effects.—The severity of the wound of a joint depends not only on the size of the articulation, but on the nature of the wound, and the age of the patient.

When a small joint, as that of one of the fingers, is opened, the injury may often be recovered from, without destruction of the articulation. When a large joint is opened, even by a small incised or punctured wound, there is great danger lest such extensive local mischief and constitutional disturbance ensue as to lead to the destruction of the articulation, with danger to the patient's life. When the wound is large, lacerated, or contused, with fracture of the articular ends of the bones, one or other of these consequences will certainly result. It is especially in adults that these unfavorable results ensue; in children, extensive injuries of large joints may heal favorably; though, if the child be of a strumous habit of body, destructive action is apt to be set up.

Traumatic Arthritis.—The source of danger in a wounded joint is the inflammation set up in the articulation. A few hours after the infliction of the injury the joint swells, becomes hot and painful, and throbs. If, under proper treatment, resolution be effected, these inflammatory symptoms will gradually subside, leaving the articulation weak, tender, and stiff for some considerable time. Should, however, the inflammation continue, the pain increases, becoming tensive and excessively severe. If the aperture be large, synovia freely escapes, which soon becomes mixed with inflammatory products. If it be small, little more than a puncture, the joint swells and fills with purulent fluid, which will either escape through the original wound, or find an outlet for itself through a new opening. There are start-

ings in the limb, with excessive pain in any attempt at moving it. The constitutional disturbance becomes very severe, the patient being occasionally carried off by the violence of the irritative fever. In other cases symptoms of purulent absorption come on, and death results from pyæmia.

If the patient survive this period of acute action, abscesses will form around and above the articulation; and the discharge from these, as well as from the joint, induces irritative fever and hectic. Should this danger be passed through, and the patient eventually survive, it will be with a partially anchylosed limb, the utility of which is greatly impaired.

The severity of the symptoms in the wound of a large joint is evidently dependent on the extent and depth of the synovial membrane which suppurates, wounds of ginglymoid being hence more dangerous than those of orbicular joints; and on the pus thus formed being pent up in the midst of tense and unyielding tissues, from which it has not a free exit. It is the admission of air into the joint that occasions the suppuration; for we find that, in the most extensive subcutaneous wounds and lacerations of joints, such as occur in dislocations and simple fractures in which the capsule is widely torn, the ligaments ruptured, the incrusting cartilages and synovial membrane broken through, and the interior of the joint filled with blood, suppuration never takes place, but the lacerated joint-structures heal kindly and well in a few weeks, leaving the articulation almost unimpaired in its movements. The presence of air appears also to exercise an injurious influence upon the pus that is collected in the depths of the joint, causing it to become putrescent and acrid, and thus greatly increasing the local irritation. It is also this retention of acrid and putrescent pus, in contact with a large inflamed surface, that gives rise to ataxic fever and pyæmia, which so frequently prove fatal in these injuries. Of all wounds of joints, gunshot injuries are necessarily the worst. In these the aperture cannot possibly be closed and united by the first intention; it and the track of the ball must suppurate. The bones are also usually splintered, and foreign bodies of various kinds are introduced into the articulation; hence the most extensive disorganizing and fatal mischief commonly ensues.

Traumatic arthritis differs from the destructive and disorganizing idiopathic inflammations of joints in this: that, when the inflammation occurs as the result of a wound, the synovial membrane is the part primarily affected; if the cartilages become involved, they are so secondarily; the articular ends of the bones not participating in the morbid action. When a joint is the seat of disorganizing inflammation of an idiopathic character, the mischief usually commences in the osseous articular ends, or in the cartilage, the synovial membrane being often the last affected. In the traumatic form, the disease may be said to radiate from the centre of the joint; in the idiopathic, to proceed from the circumference.

In recent cases of traumatic arthritis we find the synovial membrane swollen, infiltrated, gelatinous in appearance, and of a crimson color; the contiguous or subjacent portions of cartilage are softened and partially eroded. Under the microscope, a disruption of the cartilage-cells may be observed, and the intervening substance is granular; these changes gradually cease in deeper sections of the cartilage, which will be found to present a healthy appearance. In the more advanced stages of the disease, when the joint has been suppurating perhaps for months, it will be found that the synovial membrane is deeply vascular in places, in other parts pulpy and infiltrated with, or replaced by, grayish or yellowish plastic matter. The cartilages are eroded in patches exposing the rough and injected surfaces of the articular extremity of the bone; where not eroded, they are pulpy and disorganized. Occasionally partial but unsuccessful attempts at bony union will have been set up between the opposite exposed osseous surfaces.

In the *treatment* of wounded joints, the first point to be determined must be whether amputation or resection should be performed, or an attempt made to save the injured joint. If the joint be small, and the disorganization of bones or soft parts not very great, there can be no doubt that we ought to attempt, and shall usually be able, to save it. But if it be one of the larger articulations, the line of practice must be determined by the extent of the injury to the soft parts and bones, and the age and constitution of the patient. If the wound be but small and clean cut, no surgeon would be justified in having recourse to immediate amputation, even though it be the knee that is injured. But if the joint have been extensively laid open, with much contusion and laceration, complicated perhaps with disloca-

tion, or with fracture and splintering of the bones, the case is different. In these unfavorable circumstances, however, in the upper extremity, and even in the ankle, the limb may not unfrequently be saved. If the bones be comminuted, the removal of splinters and resection of the articular ends may advantageously be practised in many cases, more particularly if the patient be young and sound in constitution, and the soft parts not too extensively damaged. But if these be largely lacerated and widely contused, and the patient aged or broken in health, amputation is imperatively called for. This is more especially the case when the knee is the articulation injured; extensive lacerations of this joint, more particularly when complicated with dislocation or comminution of the bones, being cases for early amputation.

If it be determined to make an attempt at saving the joint, the principal point is, if possible, to close the wound by the first intention, and thus to prevent the occurrence of suppuration. If it be a puncture, or small clean cut wound, this may occasionally be done by bringing the edges together and placing a piece of lint soaked in collodion upon it, or a strip of plaster washed over with resin varnish. The joint must then be placed in a splint so as to be rendered absolutely immovable, and should then be surrounded by India-rubber bags containing pounded ice. In fact, the three great principles of treatment in the early stages of wounds of joints consist in the exclusion of air, perfect rest, and the continuous application of cold. In this way inflammatory action may be prevented, and union of the wound may take place under the plaster; but in the majority of cases the inflammation that is set up in the joint causes so abundant a secretion of synovia, that the dressing becomes loosened by the tension and outward pressure of the accumulated fluid which escapes from under it. If the preventive means of arresting inflammation fail, and the joint swell, becoming red, hot, and throbbing, with much constitutional irritation, the line of treatment must be changed, and means should be taken to limit the inflammatory action. This is best done by the free application of leeches over the joint, hot fomentations, and the internal administration of calomel and opium about four times in the day. This remedy possesses a more decidedly controlling influence over traumatic arthritis than any other with which I am acquainted.

If suppuration have come on, long and free incisions should be made into the joint so as to procure an early outlet for the pus; the part must be well poulticed, and an attempt made at procuring anchylosis by the granulation and cohesion, through fibrous tissue, of the articular surfaces. Puncturing the joint is worse than useless. By a puncture, the pus cannot be evacuated from a deep and complicated joint, the air is admitted, and decomposition of secretions with irritative fever and pyæmia ensues; but, by making free and early incisions into the joint after suppuration has once been set up, the dangers resulting from decomposition of the pus and its absorption into the system are in a great measure lessened, and the constitutional irritation produced by the tension of the parts is at once removed. The joint itself is not put into a worse condition by being more freely opened; for, when once suppuration has been set up in it, even to a limited extent, destruction of its tissues must ensue; and the most favorable termination that can be expected is the production of anchylosis. When suppuration of a joint has taken place, one of three things will happen; the patient may recover with a stiff joint, amputation may become imperative, or he may die from constitutional irritation. The most favorable result that can be anticipated, therefore, is a stiff joint, and this the surgeon should endeavor to obtain.

If the case proceed favorably, the discharge will gradually lessen, and the constitutional disturbance subside. The joint must then be placed in such a position, that, when anchylosis results, the limb may be most serviceable to the patient.

If, however, as very frequently happens when the larger joints are wounded, the suppuration within the articulation, and the abscesses that form outside it, reduce the patient to a hectic state, secondary amputation speedily becomes inevitable.

Wounds of Individual Joints.—To the preceding general principles I have little to add with respect to wounds of the individual joints.

The *hip* and *shoulder* are so deeply placed, and so well protected, that they can scarcely be wounded except as the result of gunshot injury, the treatment of which condition has already been discussed (pp. 149, 150).

Wound of the *knee-joint* is one of the most common and most severe of such injuries. When the result of gunshot violence, it imperatively demands immediate

amputation. When produced by a puncture or clean cut, the wound must be closed, and cold irrigation and leeches may be employed assiduously. Should suppuration occur, the joint must be freely laid open by long incisions, and commonly amputation will be required. The abscess will often form deeply in the thigh rather than in the joint itself; and in a very insidious manner. The limb swells up to the trochanters, becomes very tense, painful, hot, and œdematous, with great constitutional disturbance and irritative fever. But the joint may be but little swollen, and many days will often elapse before fluctuation can be felt in it, or in the thigh. It is this absence of swelling in the knee itself that may mislead an inexperienced practitioner. At length the abscess may approach the surface near the knee; and, on an incision being made, an immense quantity of pus is discharged. The abscess forms as a consequence of the escape of some of the irritating contents of the suppurating synovial membrane close upon the anterior surface of the femur; it creeps up and surrounds the bone under the deep muscles of the limb, which are separated from the bone, and may reach as high as the trochanters before it is detected. It is this depth in the limb at which the abscess is seated that occasions the remarkable difficulty in its detection, the violent constitutional disturbances it occasions, and its extreme danger. I have never seen abscess form amongst the muscles of the leg as a consequence of injuries of the knee-joint, unless the tibia had been fractured as well as the joint opened.

For the penetration of the knee-joint by needles, see p. 154.

Wounds of the *elbow* and *ankle-joints*, when simple, as in punctures, usually admit of closure and of being healed, leaving a sufficiently useful and mobile articulation. When they are complicated with fracture of the neighboring bones, the soft parts not being too extensively injured, resection of the injured articulations is the proper course; if there be much laceration of soft parts with comminution of the bones, amputation, especially in the case of the ankle, will be required.

Wounds of the *wrist-joint* are peculiarly dangerous, on account of the nature and complexity of the synovial membrane that enters into its conformation, should suppuration be set up. Some of the carpal bones may necrose, and thus amputation may be rendered imperative; or, if this be averted, a stiff and comparatively useless hand be left.

Dislocations will be described in Chapter XX.

CHAPTER XVIII.

FRACTURES.

THE management of fractures constitutes one of the commonest duties of the surgeon, and hence the consideration of all that relates to their nature and treatment is of the utmost importance.

Causes.—Fractures may occur from two causes—*external violence and muscular action.* They are almost invariably the result of external violence, but the liability to their occurrence is more or less modified by certain predisposing circumstances.

Local Causes.—External violence may be applied in two ways; directly or indirectly.

The worst forms of fracture are occasioned by *direct external violence*, the blow crushing and splintering the bone, as by the passage of a heavy wheel or a gunshot injury. When the bone is broken by direct violence, the fracture is always at the seat of injury, and is often complicated with considerable mischief to the soft parts, the result of the same force that breaks the bone.

Indirect violence, may break a bone in two ways. One that is more commonly talked of than seen is by *contrecoup*, in which, when a blow is inflicted on one part, the shock that is communicated expends its violence on the opposite point, where the fracture consequently occurs. This form of injury is chiefly met with in the head; and, although its occurrence has been denied, I cannot doubt it, as I have seen unequivocal instances of this kind of fracture.

In the next form of indirect violence occasioning fracture, the bone is broken by being snapped, as it were, between a resisting medium on one side, and the weight of the body on the other. Thus, a person jumping from a height and alighting on his feet, may break his legs by their being compressed between the weight of the body above and the ground below. The long bones are those which are most frequently fractured in this way; and the fracture occurs at the greatest convexity, or at their weakest point. When a person jumps from a carriage that is in motion, although the height of the fall be not great, yet its force is considerable, the body coming to the ground with the same velocity as that with which it was being carried onwards in the vehicle. Hence, fractures received in this way are usually severe, and often compound or comminuted.

Muscular action is not an unfrequent cause of fracture of those bones into which powerful muscles are inserted. This is especially the case with the patella and some of the bony prominences, such as the acromion, which are broken in the same way that a tendon is ruptured—by the violent contraction of the muscles attached to them tearing them asunder. It is not often that the long bones are so fractured; yet the humerus occasionally is. Thus, it has happened that this bone has been broken by a person striking at but not hitting another, or by suddenly throwing out the arm to seize something that was falling; or that the clavicle has been fractured by a rider giving his horse a back-handed blow. In these cases, however, muscular action may not have been the sole cause, the weight of the limb also tending to fracture the bone. Those bones that do not offer attachment to any powerful muscles, as the cranial, for instance, cannot be fractured in this way.

Predisposing Causes.—These are numerous and varied.

Some bones are especially liable to be broken in consequence of their *serving as points of support.* Thus, when a person falls upon the hand, the shock is transmitted from the wrist-joint through the radius, humerus, and clavicle, to the trunk; the radius and clavicle, being the weaker bones, are especially liable to be fractured in these circumstances. So again, the *situation* of a bone, irrespectively of use or any other circumstance, may predispose it to fracture; the prominent position of the nasal bones, and the exposed situation of the acromion, render these parts peculiarly liable to this injury. The *shape* of some bones disposes them to fracture; thus, a long bone is necessarily more readily broken than a short and thick one; hence fractures of the tibia and femur from falls on the feet are more common than of the os calcis. *Certain parts of bone* are more commonly fractured than others. Those points especially into which powerful muscles are inserted, or that are in exposed situations, and hence liable to injury, or to receive the weight of the fallen body, are often broken. Hence the acromion, the olecranon, and the neck of the femur, are commonly fractured.

Age exercises considerable influence, not only on the general occurrence of fracture, but on the peculiar liability of certain bones. Though fractures may occur at all ages, even in intra-uterine life (Chaussier having dissected a fœtus that had 113 fractures), yet bone, being elastic and cartilaginous in early age, is less readily broken than when it has become brittle and earthy, as in advanced life. In children, fractures most commonly occur in the shafts of the long bones; or at the point of junction between the shaft and epiphysis, where ossification has not as yet taken place. This separation of the epiphysis in children, the detachment as it were of the terminal points of ossification, is not unfrequently met with, and occurs chiefly at the lower ends of the humerus and femur, sometimes in the radius and other bones. As age advances, the compact tissue of the shaft becomes denser and harder, but the cancellous structure of the extremities more dilated, and looser; hence fracture of the neck of the femur is especially common in old people. In young persons also, the bone is usually simply broken transversely, but fractures taking place at a more advanced period of life generally assume an oblique direction, and become comminuted; so also they more commonly extend into joints than when occurring in early age.

Fracture termed *spontaneous* sometimes happens without any very direct cause, or under the influence of violence that would usually be insufficient to occasion it. This may happen in consequence of the texture of the bone being weakened or rendered more brittle by disease, such as mollities or fragilitas ossium, by the cancerous cachexy, by syphilis, by the presence of cancerous growths within the substance of the bone itself, or by the pressure upon, and absorption of it, by some

neighboring tumor. In other cases, again, it occurs without any apparent disease, local or constitutional. This usually happens as the result of the brittleness and weakening induced by age. I have known a gentleman little above fifty, apparently in perfect health, break his thigh with a loud snap whilst turning in bed. In these cases union rarely takes place, or not without much difficulty.

Sex necessarily influences the liability to fracture, men being more frequently exposed to the causes of this injury than women. In women, the bones that are most commonly fractured are the clavicle, the tibia, and the neck of the femur. In men, the shafts of the long bones, the cranium, and pelvis, are most frequently broken.

From statistical accounts it would appear that the right limbs are more frequently broken than the left, being more exposed to the causes of fracture. It has been supposed that the bones are more brittle in winter, and hence break more readily than at other seasons; but this is altogether a mistake, though fractures may be common at this period of the year, from falls being more frequent.

Varieties.—Fractures present important varieties as to their *nature* and their *direction*. The varieties as to nature depend upon the cause of the fracture, its seat, and the age of the patient.

Nature.—Fractures are divided into two great classes, according as they are unaccompanied or attended by an open wound leading down to the fracture—the first being called *simple*, the second *compound*. In the first class are included the *simple fracture*, where the bone is merely broken across, split, or fissured; the *impacted*, where one fragment is wedged into another, the compact tissue being driven into the cancellous structure; and the *comminuted*, where the bone is broken into several fragments.

When the soft parts covering the broken ends of bone are torn through, so that the fracture communicates by a wound with the surface of the body, it is said to be *compound*. The fracture may be rendered compound in two ways; either by the same injury that breaks the bone lacerating the soft parts, as when a bullet traverses a limb, and fractures the bone; or else by the protrusion of one of the extremities of the broken fragments through the integuments covering it. This necessarily most frequently happens when the fragments are sharp and pointed, and the coverings thin, as in fracture of the tibia, and may be occasioned either by muscular contraction driving the fragment through the skin, or by some incautious movement on the part of the patient forcing it through.

A fracture is said to be *complicated* when the injury to the bone is conjoined with other circumstances which are perhaps of more importance than the mere fracture itself, the complication constituting often the most serious part of the injury, and influencing greatly the general result of the case. Thus, a fracture may be complicated with injury of an important internal organ, as of the brain, lungs, or bladder; the injury to the organ being inflicted by the projection against it of one of the broken fragments. So also, a fracture is not unfrequently complicated with the wound of one of the principal arteries of the part, as happens especially in the leg, where the tibial arteries, being in close contact with it, are often torn by the broken bone. In other cases, again, the fracture is associated with injury of a joint, or dislocation of it. Besides these varieties of fracture, it occasionally happens that a bone is only cracked, or partially broken. This especially occurs in the bending of bone in children, in which cases the fracture may be *partial* or *incomplete*, merely extending across the convexity of the curve made by the bone. This is sometimes called the "*green-stick*" fracture. *Intraperiosteal* fractures have been described; but this is an anatomical refinement of little practical value.

Direction.—The direction assumed by fractures varies greatly, and depends materially on the cause of the injury, as well as upon the bone that is fractured.

The line of fracture may run through a bone in three different directions: either *transversely*, *obliquely*, or *longitudinally* to its axis.

The *transverse fracture* is the simplest, and is seldom complicated with injury to the neighboring parts. It chiefly occurs in children, and very frequently in the articular extremities or processes of bones; it unites readily, and is attended by but little displacement; it is most commonly the result of direct violence, but it may arise from muscular action, as in the case of the patella, which is usually broken in this way.

The *oblique fracture* commonly occurs from indirect violence; the breaking force being applied to the ends, and not across the shaft. It often runs a long

way, more than half the distance of the shaft of a bone, and is more dangerous than the transverse, owing to the obliquity of the fracture causing the ends of the bone to be sharply pointed (Fig. 99, *a*), and thus frequently to puncture the skin, or to perforate an artery. It is tedious in its cure, owing to the fragments being less directly in apposition; hence, also, there is a greater liability to shortening of the limb; it is principally met with in the shafts of the long bones of adults and elderly people.

Fig. 99.

Oblique and longitudinal fractures.

The *longitudinal fracture* consists of a splitting or fissuring of a bone in the direction of its axis (Fig. 99, *b*). Longitudinal fracture, or splitting of bone is not very common in civil practice; but in military practice it is of frequent occurrence, especially from the action of conical rifle balls. In such cases when the shaft is struck and shattered, the splitting of the bone may extend widely in either direction—sometimes into the neighboring joint, although, as Stromeyer has remarked, it usually stops short of this, terminating at the epiphysis. When produced by a blow, and sometimes not a very severe one, upon the articular end of a bone, this i
opened.

The separation of the epip
from the shaft, at the line of
accident that occasionally occ
at any period up to that of t
between the parts. Hence it
age of 21 or 22. This kind c
ends of the femur and of the tibia, and at either
of the *upper* epiphysis of the tibia, though ve
Madame Lachapelle met with a case where the
and I have myself seen a well-marked example o
accident, the nature of the injury being establishe
in the museum of the Episcopal Hospital.—A.]
to stimulate a dislocation very closely; but the
its movements may usually be ascertained to be
place. Not only are the epiphyses of the long bon
the line of junction, but the same thing may ha
acromion, olecranon, &c.; and some osseous s
sternum, are apt under external violence to sep
parts.

Signs.—The signs of fracture, taken individu
equivocal, and may arise from other conditions of
injuries. It is rather by their simultaneous o
pathognomonic of the existence of a broken bon

Amongst the more equivocal signs may be n
the limb, which may be owing either to the la
broken fragments, or to the general injury inflic
of increased or diminished swelling is observed
augmented swelling being owing either to the e
which often takes place to a very considerable
any principal vessel; or to the approximation o
the shortening of the limb. Diminished swel
cases, in consequence of the weight of the lim
lessening natural rotundity.

The more special and peculiar signs of fr
change in the shape of the limb; 2. Mobility in
of grating between the broken ends of the bon

1. The *change in the shape of the limb*, due
the broken bone, is perhaps the most important
by a want of correspondence between the oss
body, by an increase or diminution of the natural curves of the limb, by angularity, shortening, or swelling.

In investigating the existence and extent of displacement in a case of fracture,

the surgeon should always strip his patient, and compare the points of bone on the opposite sides of the body, and their relative situation to some fixed and easily distinguishable neighboring prominence on the trunk or injured part of the limb. From this the measurements may be taken, by grasping the injured part and the corresponding portion of the healthy limb in each hand, and running the fingers lightly over the depressions and elevations, marking any difference that exists; or, if greater accuracy be required, measuring by means of a tape. In some cases the measurement must not be made between the trunk and the limb injured, or even from one extremity of the limb to the other, as shortening of the whole member might depend on other causes than fracture, such as wasting disease of joints, or dislocation; when this is the case, the measurement must be taken between different points of the bone actually injured.

The displacement of a broken bone may be the direct result of the violence which occasions the fracture, the fragments being driven out of their position, as when a portion of the skull is beaten in; or it may result from the weight of the limb dragging downwards the lower fragment, as in a case of fractured acromion. In some cases, it is either occasioned, or greatly increased by the direction of the fracture. Thus, in several cases of broken tibia which have been under my care, the line of fracture being oblique from above downwards, and from before backwards, I have found the upper end of the lower fragment project considerably forwards, sliding, as it were, along an inclined plane in the upper fragment; and in one of these cases, which I had an opportunity of dissecting after amputation, the direction of the fracture, rather than muscular action, appeared to be the cause of displacement. In transverse fractures there is always but slight displacement.

Muscular contraction is, however, without doubt the most active cause of displacement: hence it has been found that, in paralyzed limbs which are fractured, there is but little deformity. The contraction of the muscles of the part approximating their points of attachment, owing to the support or resistance offered by the bone being removed, draws the most movable fragment out of its normal position. The other causes that have just been mentioned, tend greatly to favor this kind of displacement; but in some cases, as in fractured patella, the displacement is entirely muscular, and in all fractures of the long bones it is chiefly due to muscular contraction.

The *direction of the displacement* is principally influenced by the direction of the fracture, the position of the limb, and muscular action; it may be angular, transverse, longitudinal, or rotatory.

In the *angular* displacement there is an increase of the natural curvature of the limb, the concavity of the angle being on the side of the most powerful muscles; thus, for example, in fracture of the thigh, the angle projects on the anterior and outer side of the limb, because the strongest muscles, being situated behind and to the inner side, tend, by their contraction, to approximate the fragments on that aspect. This displacement principally occurs in oblique and comminuted fractures.

The *transverse* or *lateral* displacement occurs when a bone is broken directly across, the fragments often hitching one against another, and so being, as it were, entangled together. In this case there is often but very little deformity.

In the *longitudinal* displacement there may be either shortening or elongation of the limb. When there is shortening, as most commonly happens in oblique fractures, it is dependent on muscular contraction, the broken ends of bone being brought together so as to overlap one another, or "riding." In other cases, the shortening may be owing to the impaction of one fragment in the other. In some cases there is preternatural separation of the fragments, the weight of the limb tending to drag the lower one downwards, or muscular contraction drawing the upper one away from it.

The *rotatory* displacement is owing to the contraction of particular sets of muscles twisting the lower fragment on its axis, as well as producing shortening of the limb. Thus, the external rotators in fractures of the neck of the thigh-bone, and the supinators in some fractures of the radius, have a tendency to twist or rotate the lower fragment in an outward direction.

2. The occurrence of preternatural *mobility in the continuity* of a bone cannot exist without fracture, and separation of the fragments from one another; hence its presence may always be looked upon as an unequivocal sign of the bone being broken. It occasionally happens, however, that fracture may take place, and owing

to the impaction or wedging together of the fragments mobility may not be perceived; hence its absence cannot in all cases be construed into a proof of the non-existence of fracture.

3. Another sign of much value in practice is the occurrence of *crepitus*, or rather of the *grating together of the rough surfaces of the broken bone*, which can be felt as well as heard on moving the limb. This grating can only occur when the fragments are movable and in contact, and is especially perceptible when the rough ends of the broken bone are directly rubbed against one another, and not the smooth periosteal surfaces merely opposed or overlapping. It is not, however, an invariable accompaniment of fracture; being absent in some cases, in which the fracture is firmly impacted, or when the fragments are widely separated. It must not be confounded with the crepitation that occurs in the limbs from other causes, as from emphysema, or from the effusion of serous fluid into the sheaths of the tendons, which gives rise to a peculiar crackling sensation, very different from the rough grating of a fracture.

It will thus be seen that each of these symptoms, taken individually, is more or less equivocal, and that it usually requires a combination of at least two of them to determine whether fracture exists. In ascertaining the existence of a fracture, the surgeon should make the necessary manipulation with the utmost gentleness, but yet effectually, so that no uncertainty may be allowed to remain as to the seat and nature of the injury, more especially when it occurs in the vicinity of a joint. The increased mobility may be ascertained by fixing the upper fragment, and rotating the lower portion of the limb; the grating by drawing down the lower fragment, so as to get the rough surfaces into apposition, and then grasping the limb at the seat of fracture with one hand, and rotating it gently with the other. The displacement must be ascertained by measuring the limb carefully in the way that has been directed, and by comparing the injured with the sound side.

Diagnosis.—The diagnosis of the existence of an ordinary fracture is seldom attended by any material difficulty. The coexistence of displacement, of mobility, and of grating, will usually enable the surgeon at once and readily to pronounce with certainty its existence, when it is *simple*. When it is *compound*, there is frequently the additional evidence afforded by the protrusion of the end of one of the fragments; and if it be *comminuted* as well, the loose splinters will be readily felt.

There are, however, two conditions that render the detection of a simple fracture occasionally difficult. The first is, when only one of two or several bones is broken; the other, the impaction of the fragments.

When only one bone is broken in a situation where there are two or more, as in the leg, forearm, metacarpus or metatarsus, it may require very close and careful manipulation of the injured bone before the fracture can be detected. The surgeon must run his finger carefully over the most projecting ridge, feel for slight inequality, or œdema at one part, and perhaps elicit the faintest occasional crepitus on fully and deeply moving the bone at the seat of suspected fracture.

In the case of impaction the diagnosis is even more difficult. Here no crepitus, and no preternatural mobility, can be found; but the surgeon must be led to his diagnosis by the recognition of the peculiar displacement and distortion which may be characteristic of the particular fracture, as, for instance, the deformity about the wrist in an impacted fracture of the lower end of the radius.

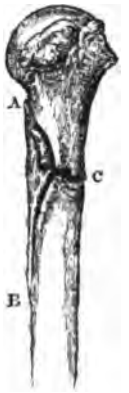
The difficulties of diagnosis in fracture of a single bone, or in an impacted fracture, are necessarily most seriously increased if there be much extravasation of blood into the limb; or, when the fracture is through an articulated end, if there should be much effusion into the neighboring joint.

As has already been stated, the existence of a fracture when *compound*, and more particularly if *comminuted*, is usually readily determined. Here, the great mobility, the protrusion of fragments or splinters, and the ready crepitus, will seldom allow the surgeon to be at fault. Should any doubt exist, the introduction of the finger into the wound will enable the practitioner to determine with certainty, not only the existence, but the condition and extent of the fracture.

But with all the assistance that may thus be afforded, it is important to observe that the very existence of a bad compound and comminuted fracture may be unsuspected for many days, even though most careful examinations have been made with the view of ascertaining its presence. Of this important fact, which may have weighty bearings in medico-legal investigations, the following case is a good illus-

tration. A young man was shot with a wooden ramrod through the left hand and shoulder, by the accidental explosion of his gun whilst he was loading it. The ramrod struck the humerus three inches below the shoulder-joint, full on its fore part. It was splintered against the bone, the fragments passing on each side, and mostly escaping through two apertures of exit posteriorly; some passing to the inner side between the large vessels and the bone, the others to the outer side between it and the deltoid. The patient was brought to the hospital, where I saw him a few hours after the injury, and, enlarging the wounds, extracted a number of splinters of the ramrod from around the bone. The limb was carefully examined, not only by me, but by several other surgeons present, to determine whether the bone had been fractured, or the joint injured. There was no sign of fracture detected—no shortening, no mobility, no crepitus, no inequality when the fingers were freely passed into the wounds. It was determined that no fracture existed, and the limb was accordingly laid on a pillow, and irrigation employed. Erysipelas set in, followed by extensive and deep suppuration in the limb. On examining this, with the view of giving a free exit to the discharges, eight days after the accident, displacement and crepitus were for the first time found, and it became evident that the humerus had sustained a comminuted fracture. The patient died of pyæmia; and after death the bone presented the appearance here given (Fig. 100), a long splinter having been detached in a longitudinal direction, A B, and the shaft broken across at C. Here, then, was not only a compound, but a comminuted fracture, detected for the first time a week after the infliction of the injury. It appeared probable that the blow of the ramrod had fractured the bone longitudinally, detaching the large splinter, which had become impacted; and that the shaft still held together by a narrow bridge of bone at C, which being broken across subsequently in moving the limb, now become heavy by inflammatory infiltration, led to the shortening of the limb and the lateral displacement of the fragments.

Fig. 100.



Comminuted fracture of the humerus.

Union of Fractured Bone.—A fractured bone is ultimately united by being soldered together by the deposition of new bone around, within, and lastly between the broken fragments. In exceptional cases, as in fractures occurring within the capsule of a joint, and in those of the patella and the olecranon, union is effected by fibrous or filamentous tissue. In some instances that will hereafter be considered, owing to peculiar local or constitutional circumstances, new bone is not formed, but the uniting medium is of a fibrous character.

The new bone that constitutes the bond of union is termed *callus*. In many cases a larger quantity of this is temporarily deposited than is permanently left. This temporary formation of bone goes by the name of the *provisional callus*. It is formed partly external to the fracture, incasing the broken ends, and partly in the medullary canal, so as to include the fragments between layers of new bone, and thus maintain them in contact. That which is permanently left, and which intervenes between the broken ends, is called the *definitive callus*. The process of union varies somewhat in simple and in compound fractures.

Union of Simple Fractures.—The production of callus has been studied with much care by Haller, Duhamel, Bordenave and Hunter, by Dupuytren, Breschet, and Villerme, and more recently by Stanley and Paget. From the observations of these pathologists, it would appear that the union of a broken bone takes place through the medium of plastic matter, deposited by a process of adhesive inflammation set up in the injured bone itself, in its periosteum, and in the neighboring soft parts; the lymph thus formed gradually undergoing development into osseous tissue. The whole process, indeed, is strictly analogous to that which takes place in the ordinary healing of a wound by adhesion and the development of the cicatricial tissue. The broken fragments are at first movable, and surrounded by a considerable extravasation of blood. In the course of ten or fourteen days, this has ordinarily undergone absorption to a considerable extent; the periosteum and the medullary membrane in the vicinity of the fracture, the tissues around it, and the broken bone itself, become very vascular, and pour out a quantity of lymph between and around the fragments, as well as within the medullary canal, so that the fractured ends are ensheathed by a reddish gelatinous mass of a fusiform shape, thickest opposite the

seat of injury. This gradually becomes more and more consolidated; and, in proportion as it becomes firmer, the mobility of the fragments lessens, and, the ends of the bone becoming smooth by the plastic deposit being adherent to and interposed between them, grating is less distinct. From the third to the fourth week the lymph has assumed a sufficient degree of firmness to keep the fragments in apposition, though the bone still yields readily at the seat of fracture. This lymph, which is poured out not only by the periosteum and bone, but by all the soft parts in the neighborhood of the fracture, gradually undergoes ossification, the bony matter being first deposited in a granular manner, but in sufficient quantity by the sixth or eighth week to unite the fracture rather firmly. The callus, which is at first soft and spongy, and differs from old bone in its microscopic as well as ordinary physical characters, gradually assimilates to old bone, both in hardness and in structure, osseous corpuscles and vascular laminated canals being formed in it; and it becomes smooth on the surface, being invested by a dense cellulo-fibrous periosteum, until, by the end of six or eight months, ossification is perfect. The last process in the consolidation of the fracture is the formation of new bone between the broken ends. This does not take place definitely until a considerable period after the ensheathing callus has been formed. This bone is deposited in the plastic matter effused between the fragments, which undergoes ossification in the same way as the external callus does. By the time that this intermediate or definitive callus is fully formed, that portion of the ensheathing or provisional callus which is not required for the preservation of the permanent integrity of the bone, has been gradually removed, or has moulded itself closely to the shape and condition in which it will ultimately remain, the medullary canal having again become free, and the ends of the fracture rounded off. In some cases the medullary cavity is not restored to its former condition for a considerable time, continuing to be partially occluded by a thin septum of callus.

According to Paget, the plastic matter that is effused around and between the bones undergoes ossification in various ways. Those fractures that ossify quickly do so most commonly through nucleated blastema, a fine closely granular ossific deposit taking place in the blastema, and becoming converted into the laminæ of the cancellous tissue, the nuclei becoming probably converted into bone-corpuscles. In other cases again, the nucleated cells of granulations and plastic effusions ossify by being transformed into bone. Then, again, the new bone may be formed by the plastic exudation passing, first of all, through the stages of fibrous tissue, of cartilage of the purest fœtal form, or through fibro-cartilage.

In those fractures that are transverse, and that remain in steady apposition during ossification, and more especially if they be but thinly covered by soft parts, the union appears to take place directly and immediately between the opposed osseous surfaces; there being no appearance of those accessory deposits of bone that usually go by the name of "provisional callus." If, however, the fracture occur in a bone that is thickly invested by soft parts, masses of new bone will be thrown out around the fragments, evidently the result of deposition from the surrounding inflamed tissues, rather than from the injured periosteum or bone. The influence of the neighboring soft parts in determining the deposits of new bone is well marked in the tibia. In a fracture of this bone we find that, at the anterior and inner part, which is thinly covered, union takes place directly between the broken ends: but at the posterior and outer side, where there is a thick envelopment of tissue, a large mass of provisional callus will often be found, filling up even the interosseous space. That neighboring parts participate in the inflammation set up around the fracture, and throw out callus, is evident from what takes place occasionally when one of the bones of the forearm or leg is broken. Periostitis is then set up in the unbroken bone, opposite the seat of fracture, and osseous matter is sometimes deposited by it. We have specimens illustrating this point in the University College Museum.

In fractures occurring in young infants, the quantity of callus thrown out is proportionately very great. This may perhaps be owing to the difficulty of maintaining such fractures in steady apposition.

If the fracture be not well reduced, the ends not being in proper apposition, or if it be comminuted, it will commonly be found that masses of new bone are deposited as buttresses or supports; or, enveloping the splinters, consolidate them in this way with the rest of the shaft. So, also, when the fractured bones are not kept sufficiently quiet during treatment, the neighboring parts become irritated, and provi-

sional callus is formed. Hence, as Paget has remarked, we commonly find this deposit in fractures of the ribs, which are kept in constant motion by the respiratory actions. In impacted fractures there is, from the perfect apposition of the surfaces, but little callus formed.

From all this, I think it clear that in simple fractures the *provisional* callus is deposited principally by the surrounding soft tissues, and also, to a certain extent, by the periosteum and medullary canal, its quantity being dependent on the amount of irritation set up in these textures. The *definitive* callus, on the other hand, is directly and immediately formed by the vessels of the fractured bone itself, and the comparative want of vascular supply to this tissue may account for the slowness of its formation.

Union of Compound Fractures.—The difference between the union of a simple and of a compound fracture is the same as that between the healing of a subcutaneous and an open wound. In the one case the healing process takes place without any sensible local disturbance or constitutional derangement: in the other, it is accompanied by local inflammation and suppuration, and by corresponding febrile reaction. In the one case, there is no exciting cause for the development of secondary diseases; in the other, the local mischief is extremely apt to generate these in their worst forms, of erysipelas, inflammation of the absorbents or veins, and pyæmia. In compound fractures, union takes place by the ends of the bone, which lie bathed in the pus of the wound, granulating and throwing out plastic matter, which becomes directly converted into bone. There is in many cases but little provisional callus; but in most instances a large quantity of accessory osseous deposit takes place, more particularly if the displacement be considerable. The union of these fractures precisely resembles that of a wound in the soft structures—by granulation, or "the second intention;" the only difference being that the granulations which are thrown out by the bone and periosteum develope into new osseous tissues either directly or through the medium of an antecedent fibroid transformation. This process necessarily occupies a much longer time than that which is necessary for the union of simple fractures, consolidation not being effected for three or four months, and often being very considerably retarded beyond this by the separation of necrosed bone, the formation of abscesses, &c. Rokitansky is of opinion, that superficial exfoliation of that layer of bone which is bathed by the pus takes place, and that it is after this is separated that the granulations spring up, in which the new bone is deposited. I think that it admits of very considerable doubt whether this process of necrosis goes on in all cases of compound fracture.

Union of fractures, like all other vital actions, takes place more readily and much more quickly in the early periods of life than at a more advanced age, and is always more speedily accomplished in the upper than in the lower extremities.

Treatment of Simple Fractures.—In conducting the treatment of a fracture, the object of the surgeon should be not only to obtain a sound and strong limb, but one that presents as little deformity and trace of former injury as possible. In order to accomplish this, the broken ends of the bone must be brought into as perfect apposition as possible, the recurrence of displacement must be prevented, and the local and constitutional condition of the patient properly attended to.

When the surgeon is called to a person who has met with a fracture, if it be a severe one of the upper extremity, or of any kind of the lower limbs, he must see that the bed, on which the patient may have to remain for some weeks, is properly prepared, by being made hard, flat, and firm, and, if possible, covered with a horsehair mattress. The surgeon must then superintend the removal of the patient's clothes, having them ripped along the seams, so that they may be taken off with as little disturbance as possible to the injured part. He next proceeds to the examination of the broken limb, using every possible gentleness consistent with acquiring a proper knowledge of the fracture. After he has satisfied himself upon this point, the limb should be laid upon a soft pillow, until any necessary apparatus has been prepared.

Reduction.—When all has been got ready, the reduction of the fracture, or the bringing the fragments into proper apposition, must be proceeded with. This should, if possible, always be done *at once*, not only lest any displacement that exists may continue permanently—the muscles, after a few days, becoming shortened, rigid, and unyielding, not allowing reduction to be effected without the employment of much force—but also with the view of preventing irritation and

mischief to the limb, by the projection of the sharp and jagged ends of bone into the soft structures. A great deal of time is often lost, and very unnecessary pain inflicted upon the patient, and great irritation set up in the limb, by the surgeon leaving the fracture unreduced on a pillow for several days, and applying evaporating lotions to take down the swelling, and threatened inflammation, which are a consequence of the non-reduction of the broken bone. By early reduction we may sometimes prevent a sharp fragment from perforating the skin, and thus rendering a simple fracture compound, or lacerating muscles and nerves, inducing perhaps traumatic delirium, and certainly undue local inflammatory and spasmodic action.

The great cause of displacement in fractures has already been stated to be muscular contraction; hence, in effecting reduction of a fracture and in removing the displacement, our principal obstacle is the action of the muscles of the part. This must and always may be counteracted, by properly relaxing them by position; so soon as this is done, the bony fragments will naturally fall into place; but no amount of extension and of counter-extension can bring these into position, and much less retain them there, unless all muscular influence be removed.

In ordinary fractures, no force is necessary or should ever be employed for accomplishing this; but attention to the attachment of the muscles of the limb and proper relaxation of them is all that is required. In impacted fractures it is occasionally necessary to use force in order to disentangle the fragments, but this is the only form of fracture in which its employment is justifiable. In effecting the reduction, not only must the length of the limb be restored, but its natural curves must not be obliterated by making it too straight.

Prevention of Return of Displacement.—After the reduction has been accomplished, means must be taken to prevent the return of the displacement; for, if the parts be left to themselves, muscular action, or the involuntary movement of the patient, will be certain to bring about a return of the faulty position. In many cases it is exceedingly difficult to preserve the fracture undisplaced for the first few days after its occurrence, in consequence of spasmodic movement of the muscles of the limb, or of restlessness on the part of the patient. About this, however, the surgeon need not be anxious, as no union takes place for the first week or ten days; at the expiration of that time the muscles will have probably lost their irritability, and the patient have become accustomed to his position, so that with a little patience, or by varying the apparatus and the position of the limb, good apposition may be maintained.

The return of displacement is prevented, and the proper shape and length of the limb are maintained, by means of *bandages*, *splints*, and *special apparatus* of various kinds. In applying these, care should be taken not to exert any undue pressure on or forcible extension of the limb. Pads and compresses of all kinds should, if possible, be avoided; they do no good that cannot be effected by proper position, and often occasion serious mischief by inducing sloughing of the integuments, over which they are applied. Screw-apparatus has been invented with the view of forcing fragments into proper position, but nothing can be more unsurgical and unscientific than such barbarous contrivances as these.

In cases in which there is much tendency to a return of the displacement, it has been recommended to divide the tendons of some of the stronger muscles inserted into the lower fragment. This, however, can very rarely be necessary; and in those cases in which I have done it, or seen it done, no material benefit has resulted.

The *bandages* used for fractures should be the ordinary gray calico rollers, about three finger-breadths in width, and of sufficient length. In applying them, especial care must be taken that the turns press evenly upon every part, and that the bandage be not applied too tightly in the first instance. No bandage should be applied *under* the splints, more particularly at the flexures of joints, and care must be taken that the limb be not bent, or its position otherwise materially altered, after bandages have been applied. A bandage *under* the splints is not only useless, but highly dangerous, by inducing risk of strangulation. No bandage should be applied to the part of the limb that is the seat of fracture. The part below the fracture may advantageously be bandaged, in order to prevent œdema; thus, in fracture of the humerus, the fingers and forearm may be bandaged with this view, but no turns of the roller should be brought above the elbow. This point of practice I consider most important, as the application of a bandage to the immediate seat of fracture not only causes great pain and disturbance of the limb, but danger of gangrene.

When once a fractured limb has been "put up," the less it is disturbed the better. No good can possibly come, but a great deal of pain must necessarily result to the patient, from meddling with it. The surgeon should always bear in mind that, in the treatment of a fractured bone, he can do absolutely nothing to promote union, beyond placing it in a good and easy position. Nature—the natural reparative action of the body—solders the bone together; and the less the surgeon interferes with the natural processes of repair, the more satisfactorily will union be accomplished. But it is requisite to examine the limb from time to time during the treatment, and especially about the second or third week, when union is commencing, in order, if necessary, to correct displacement. In the earlier stages, supervision is necessary lest the bandage be too tight; and, if the patient complain of any pain or numbness, or if the extreme part look blue and feel cold, the bandage must be immediately removed; for, though the apparatus have not been applied tightly, swelling of the limb may come on from various causes, to such an extent as to produce strangulation and consequent gangrene of it, as I have seen happen in at least three instances, the limb requiring amputation in each case (Fig. 105). It is remarkable, that the whole of a limb will fall into a state of gangrene in these circumstances, with but little pain, and often with very slight constitutional disturbance, the parts having their sensibility deadened by the gradual congestion and infiltration of the tissues. When such an unfortunate accident happens, recourse must be had to immediate amputation. Before applying the apparatus in a case of fracture, and as often as it is taken off, it is a good plan to sponge the limb with warm soap and water, which prevents the itching that otherwise occurs and is sometimes very troublesome.

The *splints* that are used in cases of fracture are of various kinds. Tin, wood, leather, and gutta-percha are the materials usually employed. For some kinds of fracture, special, and often very complicated apparatus, is very generally used; but the surgeon should never confine himself to one material, or one exclusive mode of treating these injuries, as in different cases special advantages may be obtained from different kinds of splints. Wood and tin are principally employed in the lower extremity, where great strength is required to counteract the weight of the limb and the action of its muscles; and care must be taken to pad very thoroughly splints made of these materials. Leather, gutta-percha, and pastebbard are more commonly useful in fractures of the upper extremity, though they may not unfrequently be employed with advantage in the lower limbs. In applying them, a pattern should first be cut out in brown paper, of the proper size and shape; the material must then be softened by being well soaked in hot water, and moulded on to the part whilst soft: as soon as it has taken the proper shape, it should, if leather or gutta-percha be used, be hardened by being plunged into cold vinegar and water; the pasteboard must be allowed to dry of itself. Its edges may then be pared and rounded, and its interior lined with wash-leather or lint. These splints have the advantage of great durability, cleanliness, and lightness. The material of which the splint is composed is of less consequence than its mode of application. There are two points that require special attention in this respect: 1, that the splint be sufficiently broad to extend to the exterior of the limb, and not to press into it; and 2, that it embrace securely and fix steadily the two joints connected with the fractured bone; if the thigh, the hip and knee; if the leg, the knee and ankle. From want of attention to this point of practice much trouble is often occasioned in keeping the fragments in steady apposition, and much deformity will often result. It is impossible to keep the fragments perfectly immobile, and in close and accurate apposition, unless this very important point be attended to.

Special apparatus should be employed as little as possible in the treatment of fractures. It is scarcely ever necessary in simple fracture, and is far more cumbersome and costly than the means above indicated, which are all that can be required. I have no hesitation in saying, that a surgeon of ordinary ingenuity and mechanical skill may be fully prepared to treat successfully every fracture to which he can be called, by having at hand a smooth deal plank half an inch in thickness, and a sheet of gutta-percha, undressed sole-leather, or pasteboard, to cut into splints as required.

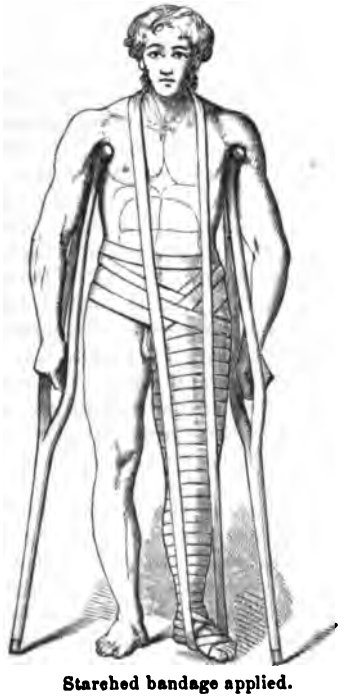
To these simple means the *starched bandage* is an invaluable addition. Although various plans for stiffening and fixing the bandages in cases of fracture, by smearing them with white of eggs, with gum, plaster of Paris, &c., have been employed at various times, it is only of late years that the full value of the starched bandage

has been recognized by surgeons, chiefly through the practice and writings of Baron Seutin.

The advantages of the starched bandage in the treatment of fractures, as well as in many other injuries and diseases, consist in its taking the shape of the limb accurately and readily, and maintaining it by its solidity; in its being light, inexpensive, and easily applied, with materials that are always at hand. It secures complete immobility of the limb in the position in which it dries. The joints in the neighborhood of the fractured bone are securely fixed, and the perfect adaptation or moulding of the apparatus to the inequalities of the limb prevents all movement. Thus it becomes a powerful and efficient extending apparatus, maintaining accurately not only the length but the normal curves of the limb. From its lightness, it possesses the very great and peculiar advantage in fractures of the lower extremity, of allowing the patient to remain up and to move about upon crutches during nearly the whole of the treatment; thus, by rendering confinement to bed unnecessary, it prevents the tendency to those injurious consequences that often result from these injuries; and, by enabling the patient to keep up his health and strength by open-air exercise, it facilitates the consolidation of the fracture. In addition to this, the patient will often be able to carry on his business during treatment. By employing the starched bandage in the way that will be immediately pointed out, I scarcely ever find it necessary to keep patients in bed with simple fractures of the thigh for more than six or seven, or of the leg for more than three or four days, thus saving much of the tediousness and danger of the treatment.

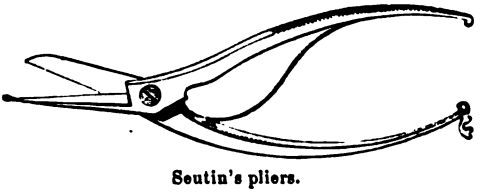
The following is the mode of applying this apparatus that is adopted at the University College Hospital, and which will be found to answer well: The whole limb is enveloped in a layer of cotton-wadding, which is thickly laid along and over the osseous prominences; over this should be laid splints of thick and coarse pasteboard soaked in thin starch, properly shaped to fit the limb, extending beyond and fixing securely the two joints above and below the fracture; the hip and knee when the thigh is broken; the knee and ankle when the leg is fractured. The pasteboard should be soft, not milled, and be doubled and torn down, *not* cut, as in this way the edges are not left sharp. If much strength be not required, as in children, or in some fractures of the upper extremity, a few slips of brown paper, well starched, may be substituted for the pasteboard. A bandage saturated with thick starch must now be firmly applied; and lastly, this is to be covered by another dry roller, the inner sides of the turns of which may be starched as it is laid on. I always take especial care not to apply any roller or bandage directly to the fractured part under the splints, and always to include in the starched apparatus the two joints that are connected with the broken bone, so that complete immobility of the fragments may be secured. During the application of this apparatus, extension must be kept up by an assistant, so as to hold the fracture in position; and, until the starch is thoroughly dried, which usually takes from thirty to fifty hours, a temporary wooden splint may be applied

Fig. 101.



Starched bandage applied.

Fig. 102.



Seutin's pliers.

to the limb, so as to keep it to its proper length and shape. The drying of the starch may, if necessary, be hastened by the application of hot sand-bags to the

apparatus. After the bandages have become quite dry, the temporary splints must be removed, and the patient may then be allowed to move about on crutches, taking care, of course, to keep the injured limb well slung up, and not to bear upon it, or to jar it against the ground (Fig. 101). In the course of about three or four days after its application, the apparatus will usually be found to have loosened somewhat, the limb appearing to shrink within it. In these circumstances it becomes

Fig. 103.

Application of Seutin's pliers to starched bandage.

necessary to cut it up with a pair of Seutin's pliers, such as are represented in Fig. 102. This section must be made along the more muscular part of the limb, so that the skin covering the bones be not injured, as represented in Fig. 103; and, after paring the edges of the splint, it must be reapplied by means of tapes or a roller. It will always be found advantageous to adopt the practice of M. Burggraeve, of Ghent, and to envelope the whole limb in a thick layer of cotton-wadding before applying the starched bandage; this, being elastic, accommodates itself to the diminution in the size of the limb, and thus keeps up more equable pressure. Indeed, of late I have invariably adopted this practice, and found much advantage from it, dispensing with any dry roller next the skin, in applying which there is always pain and difficulty, and from which there is danger of constriction or of abrasion. In trimming the edges of the splint, it should not be removed from the limb; and after this has been done, the apparatus must be fixed together again with tapes or a roller. If the fracture be compound, a trap may be cut in the apparatus opposite the seat of injury, through which the wound may be dressed (Fig. 104).

Fig. 104.

Starched bandage; trap left for dressing wound.

Although fully recognizing the great advantages to be obtained by treating fractures on this plan, and employing the starched bandage in almost every case that came under my care, I did not at first think that it was a safe practice to have recourse to it during the early stages of fracture; until, indeed, the swelling of the limb had begun to subside. I therefore never applied it until the sixth, or eighth, or tenth day, keeping the limb, until this time, properly reduced upon a splint, very lightly bandaged, and wet with cold evaporating lotions; fearing that, if the bandage were applied at too early a period, the inflammatory turgescence of the limb might give rise to a slow strangulation of it under the apparatus.

During many years, however, I have followed Seutin's plan in some hundreds of fractures of all kinds, putting the limb up in the starched apparatus *immediately* after the reduction of the fracture, and have found the practice an extremely successful one, even in fractures of the thigh; so much so, that at the hospital I now rarely use any other plan of treatment; and, indeed, the more experience I have of it, the more satisfied I am with the results obtainable by it. I find that the moderate pressure of the bandages, aided probably by the great evaporation which goes on during the drying of so extensive and thick a mass of wet starch, and which pro-

duces a distinct sensation of cold in the limb, takes down the extravasation most effectually, and enables the patient usually to leave his bed about the third day after the injury, when the fracture is in the leg or ankle, and about the sixth when it is the thigh that is broken; so that we now treat all patients with simple fractures of the leg, and many with fractures of the thigh, especially children, as out-patients.

From no other means of treatment have I seen such satisfactory results in cases of fractured thigh, as from the starched apparatus; patients having frequently been cured without any shortening whatever, with the preservation of the natural curve of the bone, and without confinement to bed after the first week.

In compound fractures also of the leg, and even of the thigh, I have obtained most satisfactory results from this means. In compound fractures of the leg, I have seen the patient walking about on crutches as early as the tenth or fourteenth day, the limb being securely put up in starch; and have more frequently succeeded in getting union of the wound, and consequently in converting the compound into a simple fracture, by putting up the limb in this apparatus than in any other.

Glue may be substituted for starch in stiffening the fracture apparatus. The glue used for this purpose should be prepared by making a strong solution of the best French glue, and then adding to this about one-eighth of spirits of wine. This mixture may then be thickly brushed over the bandage. After drying, the apparatus should be cut up, trimmed, and fixed on by straps, lacings, or bandages, as most convenient. It possesses the advantages over the starched bandage of drying more quickly, and of being lighter and more elastic, but it is not so strong or so well adapted for purposes of support when the whole of a muscular limb or large joints have to be included.

The *plaster of Paris bandage* may sometimes be advantageously used as a substitute for the starched apparatus. It may be applied in the following way. A bandage of coarse soft muslin must have dry plaster of Paris thoroughly rubbed into its meshes; it is then to be rolled up, and some cold water poured upon each end of it so as to moisten it through. A dry roller having been previously applied to the limb, the wetted plaster bandage must be smoothly rolled up it, the surgeon taking care that no reverses are made. In order to avoid these, it may be applied in a spiral or figure-of-8 manner over the more unequal parts. Slips of the plaster bandage should also be laid on where additional strength is required, and the whole well wetted from time to time during the application. It hardens in the course of a few minutes, and, as it dries, forms a solid, hard, and light casing to the limb, affording excellent support to the fracture. The plaster bandage possesses the advantage over the starched apparatus of being lighter, and especially of drying and hardening very quickly—qualities which render it invaluable in cases in which it is necessary to carry patients any distance immediately after the setting of the fracture.

In the treatment of simple fractures the following are, then, the chief points that require attention:—

1. To effect reduction at once, and with as little disturbance of the limb as possible.
2. Not to apply any roller to the part of the limb in which the fracture is situated, nor under the splints.
3. To pad or wad the splints thickly.
4. To include and fix in the apparatus the two joints connected with the injured bone.
5. To disturb the apparatus as seldom as possible.
6. To use pasteboard splints, protected by cotton wadding, and supported by the starched bandage, in preference to any more special form of apparatus.

Accidents during Treatment.—Various accidents are liable to occur during the treatment of a fracture; some of these are of a general, others of a special character. Amongst the more general accidents, tetanus, traumatic delirium, and erysipelas, may be mentioned as the most common. Amongst the more special, the occurrence of spasm of the muscles of the limb, abscess, œdema, gangrene, and a tendency to pulmonary and cerebral congestion, are those that have most to be guarded against.

In order to prevent the occurrence of these conditions, the general health must be carefully attended to; the bowels being kept open, the room well ventilated,

nourishing diet allowed, and long confinement to bed avoided by the use of the starched bandage.

The treatment of the more general accidents presents nothing that need detain us here; but those that are more special and peculiar to fractures, require consideration.

Spasm of the muscles of the limb, owing to the irritation produced by the fragments, is often very severe so long as the fracture is left unreduced; the sharp end of the broken bone puncturing and irritating the surrounding muscles. It is best remedied by reduction, and the maintenance of the fracture in proper position by moderate pressure with a bandage. If the spasm be dependent upon nervous causes, full doses of opium will not unfrequently afford relief. In some cases it is of a permanent character, producing considerable displacement of the fragments. In these circumstances, division of the tendons has been recommended; but this practice appears to be an unnecessarily severe one, and may certainly most commonly be avoided by attention to the other plans of treatment which have been suggested.

Considerable extravasation of blood is frequently met with in cases of simple fracture, causing great swelling and tension of the limb. By the continuous application of cold evaporating lotions, the collection is usually readily absorbed; and the surgeon should never be tempted by any feeling of fluid or of fluctuation to open it, as he would thereby infallibly convert the simple into a compound fracture, and give rise to extensive ill-conditioned suppuration. In some of the cases of extensive extravasation, the limb appears to relieve itself of the serous portion of the blood effused, by the formation of large bullæ or blebs, which may be punctured, or else allowed to burst and subside, without any material inconvenience. This extravasation very rarely, indeed, runs into abscess; if it do, it must of course be opened, and treated upon ordinary principles. If deeply effused it may lead to gangrene, by the constriction and compression which it exercises on the muscles of the limb.

Œdema and gangrene of the limb (Fig. 105) may occur in two ways; either as the result of tight bandaging, or else of the swelling of the limb consequent upon

Fig. 105.

Gangrene from tight bandaging.

extravasation of blood, or of inflammatory infiltration causing strangulation within a bandage that has been at first but lightly applied. It is almost invariably the consequence of the pernicious and dangerous practice of applying a bandage *directly* to the limb under the apparatus in cases of fracture. I have never known gangrene to occur after fracture, except where this has been done. If the splints be well wadded, and no bandage be put on under them, it is almost impossible that an undue or dangerous amount of constriction can be exercised on the limb, so as to interrupt the circulation through it. I believe that this accident would rarely, if ever, occur, if the surgeon were to avoid the direct application of a bandage to the limb, however lightly, in fractures, more particularly in children. The danger of strangulation is especially great if, as happened in the case from which the accompanying cut is taken, the limb be bandaged whilst straight, and then flexed, as the bandage will then cut in deeply at the flexure of the joint, and certainly destroy the vitality of the part, if not of the whole limb. Even if no *direct* bandage have been applied, the apparatus should at once be removed, and the limb examined, whenever the patient complains, even of slight uneasiness; or, indeed, if any appearance of congestion, such as blueness, coldness, œdema, or vesications of the fingers and toes, show themselves. If it be left on beyond this, gangrene will probably set in,

slow strangulation going on under the bandages without much, if any, pain. Too much importance must not be attached to the mere appearance of vesications. They will often occur of very large size, as has already been stated, as a consequence of the raising of the cuticle by the transuded serum of extravasated blood. It is only when associated with coldness of the limb, a dusky purple hue, and a putrescent odor, that they are indicative of gangrenous action. An excellent plan of judging of the activity of the circulation in a fractured limb after it has been put up, is to leave the ends of the fingers or toes uncovered by the bandage; when, by pressing upon one of the nails, the freedom of the circulation may be ascertained by noticing the rapidity with which the blood returns under it. Should gangrene unfortunately have occurred as the result of tight bandaging, or in consequence of the surgeon neglecting to examine the limb, and thus allowing slow strangulation to set in, there will be no resource but to amputate above the line of demarcation.

In fractures occurring in old people, there is a great tendency to *pulmonary and cerebral congestion*, partly from determination of blood, and partly as a consequence of the long confinement required; these fractures commonly prove fatal in this way. The use of the starched bandage, by enabling the patient to move about, is the most effectual preventive of these accidents.

Complicated Fractures.—Fractures may be *complicated* with various important local conditions. Thus the *extravasation of blood* into the limb may arise from a wound of some large vessel, and this may go on to so great an extent as to occasion strangulation of the tissues; if not checked by position and cold applications, it may give rise to gangrene, and demand amputation. In other cases, again, the soft parts in the vicinity of the fracture may be contused to such a degree that they rapidly run into slough, thus rendering it compound; or a wound may exist, not communicating with the broken bone, but requiring much modification of treatment, and special adaptation of apparatus.

One of the most serious complications of a simple fracture is undoubtedly the *rupture of the main artery* of the limb opposite the seat of fracture, or its wound by one of the fragments of broken bone. This accident chiefly occurs in fractures of the lower part of the femur or upper part of the tibia; the popliteal in one case, and the posterior tibial in the other, being the vessels wounded. The symptoms consist in the rapid formation of a uniform elastic tense swelling of the limb, with obscure pulsation or thrill, opposite the seat of injury, and cessation of pulsation in the arteries of the ankle, with coldness and numbness of the foot and lower part of the leg. If the posterior tibial be the vessel injured, the circulation in the arteries of the foot may return after a day or two, and the coldness and numbness may lessen. If it be the popliteal that is injured, no such amelioration will take place, but the diffused aneurism in the ham will increase, the circulation will become more and more impeded, and gangrene will result.

What should be the treatment of such a case as this? The surgeon has three alternatives.

1. The case may be treated as one of open arterial wound, the tumor laid open, and the injured vessel ligatured at the seat of wound. The objections to this treatment are, that a large cavity is opened, which must suppurate, and will probably slough; that the fracture is rendered a compound one of the worst kind; and that the securing the artery is, under any circumstances, in the highest degree difficult, and indeed uncertain, entailing such an amount of disturbance of the soft parts as seriously to imperil the vitality of the limb.

2. The circulation through the femoral artery may be arrested by compression or ligature of the vessel. I am not aware that compression has ever been tried in a case of diffused traumatic aneurism; but there can be no reason why the effects of pressure upon the artery, by means of Carte's or some other proper compressor, should not be tried before proceeding to more severe measures. Should it not succeed, the artery may be tied in Scarpa's triangle. But this should only be done in those cases in which, notwithstanding the existence of diffused traumatic aneurism in the ham, the pulsation has returned in the arteries of the foot, and the warmth and sensibility of the member have been in part at least restored. If these evidences of a return of circulation through the anterior tibial have not taken place, it will be worse than useless to ligature the femoral, as gangrene must inevitably ensue.

3. Amputation of the thigh may be performed. This severe measure need not

be carried out at once. The surgeon may wait a day or two and watch the progress of events. If he find that there is no sign of restoration of pulsation in the arteries of the foot, that the coldness and numbness of the limb continue to increase, and, in fact, that gangrene is impending, then the sooner he amputates the better for the patient's safety. So, also, if the artery have been tied, and gangrene result, the removal of the limb ought at once to be practised.

To sum up, I would advise, in a case of diffused traumatic aneurism arising from and complicating a simple fracture of the lower extremity: 1. Not to open the tumor and search for the artery at the seat of wound; 2. To compress or ligature the femoral, if pulsation have returned or continue in the arteries of the foot; but, should pulsation not have returned within two or three days, should gangrene be imminent, or actually have set in, or should the artery have been ligatured, and mortification have ensued, to amputate high in the thigh without further delay. It will thus be seen that, in a diffused traumatic aneurism complicating a fracture of the bones of the lower extremity, the ordinary treatment of diffused traumatic aneurism must be departed from, for these reasons: 1. That, owing to the great displacement of parts and laceration of soft structures consequent on the fracture, it would be almost impossible to find the injured vessel; and, 2. That, if it were found, the opening up of the limb would leave a large ragged wound communicating widely with the broken bones, and leading to the worst form of compound fracture, with an amount of disorganization in the limb that could scarcely be recovered from.

However extensively a bone may be comminuted, good union will take place provided the fracture be simple; that is, provided *no wound exist in the limb by which air may gain admission* to the fracture or to the soft parts implicated in it. I have seen the lower end of the femur crushed, as if by a sledge-hammer, into a multitude of fragments; and yet excellent union resulted, the fracture being simple, with no breach even of integument. In such a case as this, if there had been the smallest wound to admit air into the limb, suppurative action of the most extensive and destructive character would undoubtedly have set in, and the patient's limb at least, if not his life, would have been lost. It is impossible to overestimate the advantage of an injury of this kind being *subcutaneous*.

A serious complication of simple fractures consists in their *implicating a joint*. The fracture may extend into a neighboring articulation, and thus give rise to considerable inflammatory action; in strumous subjects this may lead to ultimate disorganization of the articulation, requiring excision, which I have several times had occasion to perform in these cases. But in healthy individuals a large articular surface may be traversed by lines of fracture in several directions, without material inconvenience resulting. This we see in impacted fractures of the condyles of the femur or of the lower end of the radius. In several instances of this kind in which I have examined the limb after death, no sign of disease of the part has been manifested beyond a moderate amount of injection of the ligaments; the fractured incrusting cartilage uniting by plastic matter, and the synovia being clear and free from inflammatory exudation. But, although union of fractures into articulations takes place readily enough, it cannot be expected that the patient will recover as mobile a joint as if the fracture had merely traversed the shaft. In fact, in the majority of these cases, the patient will be left with a joint that is weak, stiff, and painful; and, if in the lower extremity, unable to support the weight of the body for some considerable time. Possibly also, in many of these instances, an impaired joint will be left through life, as the necessary and unavoidable result of the injury, though not unfrequently unjustly attributed to negligence and want of skill on the part of the surgon.

The occurrence of *dislocation* at the same time as the fracture, and from the same violence that occasions this, often occasions great difficulty to the surgeon, as it becomes necessary to reduce the dislocated joint before the fracture is consolidated. In several cases of this description which have fallen under my care, I have succeeded in reducing the dislocation at once, by putting up the limb very tightly in wooden splints, so as to give a degree of solidity to it, and to permit the lever-like movement of the shaft of the bone to be employed; and then, putting the patient under chloroform, I have replaced the bone without much difficulty. Should the surgeon have neglected to reduce the dislocation in the first instance, it will be necessary for him to wait until the fracture has become firmly united, and then,

putting the limb in splints or in starch, to try to effect the reduction, which, however, will then be attended by very great difficulty.

The fracture in a limb which is the seat of an *old unreduced dislocation* is necessarily of very rare occurrence, but occasions no serious difficulty in diagnosis or treatment. I once saw and treated successfully with Dr. Bryant a case of this kind in the person of an old gentleman who, falling on the ice, fractured the left humerus, which had been the seat of an unreduced dislocation forwards for more than fifty years.

The existence of *an anchylosed joint* in a fractured limb is a complication that gives but little trouble, beyond the necessity of modifying the splints in such a way as to fit the shape of the limb. I have treated fractures of the thigh, leg, and arm under such circumstances with perfect success, by adapting the splints to the angle formed by the stiffened joints.

Fracture of a bone *into the site of an excised joint* presents no peculiarity of importance. I have met with it in the humerus at the elbow, and have treated the case as one of ordinary fracture of the epiphysis.

Fracture of the bone *in the stump of an amputated limb* is a rare accident. I have twice had such cases under my care; once in a man who fractured the femur low down in a limb which had been amputated below the knee, and another time in a woman who had suffered the same amputation. There was no displacement of the fractured bone in either case, showing the influence of the weight of the limb in addition to muscular contraction in occasioning displacement of the lower fractured fragment. In each case the accident was the consequence of a fall, and union readily took place under the starched bandage.

In cases of simple fracture occurring in the neighborhood of, or implicating large joints, passive motion is very commonly recommended at the end of from four to six weeks; I think, however, with Mr. Vincent, that this is often apt to do more harm than good, and is seldom required, the natural action of the muscles of the part being fully sufficient to restore the movements of the articulation, which may be assisted by friction and douches.

Amputation is but very seldom required in simple fractures, and I have never had occasion to practise it. Yet, in cases of very extensive and severe comminuted simple fracture of the lower end of the femur, or of the upper part of the bones of the leg, with implication of the knee-joint and injury to the popliteal or tibial arteries, as indicated by the cessation of pulsation in the vessels of the foot, removal of the limb might be proper, in order to save the patient from gangrene or diffused traumatic aneurism. But it is only when the main artery has been injured by spicula of fractured bone, that such fractures will require amputation. I have had under my care a man, in whom the condyles of both femora and the left patella were crushed into numerous pieces by a fall from a great height on both knees, the limbs feeling like bags of loose fragments of bone at the seat of the injury; yet, as neither the skin was broken nor the vessels injured, though both knee-joints appeared to be disorganized, the limbs were preserved, and a good union ensued.

Compound Fractures.—A compound fracture is that form of injury in which there is an open wound leading down to the broken bone, at the seat of fracture. This injury is not only far more tedious in its cure than simple fracture, but infinitely more dangerous. The tediousness depends upon the communication of the fracture with the external air, causing it to unite by a slow process of granulation, instead of by the more speedy adhesive action that occurs in the simple form of injury. The danger is likewise partly due to the same cause; the process of granulation and suppuration being often attended by profuse discharge of pus from abscesses, by long-continued exfoliation of bone, or by the supervention of secondary disease, such as hectic, phlebitis, pneumonia, or erysipelas, so as to lead to the eventual loss of limb or life. Besides these dangers, which may be looked upon as of a remote kind, the violence that occasions a compound fracture often shatters the limb to such an extent, as to lead to the immediate supervention of traumatic gangrene, to the loss of life by hemorrhage, or to the certain and speedy disorganization of the limb, as the consequence of the reactionary inflammation.

Question of Removal of the Limb.—As there are, therefore, not only prospective dangers of great magnitude to be encountered in these injuries, but also immediate risk of a very serious character to be met, the first question that always presents itself in a case of compound fracture is, whether the limb should be removed, or an

attempt be made to save it. It is of great importance to settle this point at once; for, if amputation be determined upon, recourse should be had to it with as little delay as possible, there being no period in the progress of the case so favorable for the performance of this operation as the first four-and-twenty hours. Should an injudicious attempt have been made at saving the limb, the surgeon must wait until suppurative action has been set up before he can remove it; and then, he will very commonly find that the occurrence of some of the diffuse inflammatory affections of an erysipelatous character will render any operation impracticable; or the supervention of traumatic gangrene may compel him to have recourse to amputation under the most unfavorable circumstances. At a late period in the progress of the case, amputation may be required, in order to rid the patient of a necrosed and suppurating limb that is exhausting him by the induction of hectic.

It is true that primary amputations are very commonly fatal, especially when practised near the trunk; yet this cannot with justice be urged as an argument against their performance, as recourse should never be had to *primary* amputation except in the most severe cases, in which it is evident that the patient's life must in all probability be sacrificed by the unsuccessful attempt to save the limb. In determining the cases in which immediate amputation should be performed, no very definite rules can be laid down, and much must at last be left to the individual judgment and experience of the surgeon. One will attempt to save a limb which another condemns. But, in coming to a conclusion upon this important question, he must bear in mind that, though it is imperative to do everything in his power to save a limb, yet the preservation of a patient's life is the main point, and that course is the proper one which offers the greatest prospect of effecting this. A wise conservatism is much to be applauded, but decision in determining the expediency of amputation is equally the characteristic of a good surgeon. In coming to a conclusion on a question of such vital moment as this, he must be guided, not only by the nature and extent of the fracture, but by the age, constitution, and habits of the patient; and though he may be guided by those general rules which have already been laid down at pp. 137 and 148, when treating of amputation in contused wounds and in gunshot injuries, yet he will often show more wisdom, and the greatest amount of skill, in knowing when to depart from the strict letter of surgical law, and in making a successful effort to save a limb, which, by adherence to surgical precepts, would be condemned; or in attempting to preserve the patient's life, by sacrificing a limb that is not injured to a degree that would usually be considered to justify amputation.

1. Those fractures must be looked upon as most unfavorable in which the wound is the consequence of the violence that breaks the bone, and, in which there is *much laceration of, and extravasation into, the soft parts;* more particularly if the integuments be stripped off, portions of the muscular bellies protrude, and the planes of areolar tissue between the great muscles of the limb be torn up and infiltrated with blood. Injuries of this description occurring in the lower extremity always require amputation. The danger to the patient increases not only in proportion to the amount of comminution of the bones and of injury to the soft parts, but almost in the exact ratio of the proximity of the injury to the trunk. Thus, amputation of the thigh for bad compound fracture of the leg, though a very serious operation, is sufficiently successful; but when the femur itself is badly fractured and amputation of the thigh high up is required, recovery can indeed but seldom be expected. A bad compound fracture of the thigh, high up, may almost be looked upon as a fatal accident (*vide* pp. 59–61, and 150). In the arm, such accidents are not so serious, and admit of the member being saved, unless the bones be greatly comminuted.

2. The complication of a compound fracture with the *wound of a large joint*, more especially if there be crushing or splintering of the bones which enter into its formation, with extensive laceration of the soft parts, is one of the most serious injuries that can be inflicted on a limb; and, when occurring in the lower extremity, it may be looked upon as a case for amputation—unless it be the hip-joint that is so damaged, when there will generally be so much injury inflicted upon the pelvic bones and their contained viscera, as to preclude the performance of any operation. When the elbow or the shoulder-joint is the seat of compound comminuted fracture, with extensive injury of the soft parts, and possibly laceration of contiguous nerves or large bloodvessels, the case is one for immediate amputation. But, if the injury be localized to the bones, the soft parts being in a favorable state, resection of the

articulation may advantageously be practised. This operation is usually a somewhat irregular proceeding, being conducted according to the extent of the wound, and consisting rather in picking out the shattered fragments of bone, and sawing off smoothly projecting and sharp-pointed fragments, than in methodical excision.

A peculiar accident is occasionally met with in young people, consisting in a fracture of one of the long bones, at the junction of the shaft and epiphysis, and the protrusion of the end of the shaft through the muscles and integuments. In these cases, although the fracture is in close vicinity to the joint, the articulation is not affected, and careful examination will always prove its sound condition. Reduction in such cases is difficult, and is usually impossible to maintain without sawing off the projecting end of the shaft. This is easily done, and union takes place readily between the epiphysis and the remainder of the shaft. In two instances in which I have had to do this in lads, one near the shoulder, the other near the ankle, an excellent result without impairment of freedom of action in the joint followed the injury.

3. When one of the *larger arteries of the limb has been wounded* by the violence that occasions the fracture, or has been lacerated by the broken bone itself, there may be copious arterial hemorrhage externally, as well as extravasation into the general areolar tissue of the limb. These cases most commonly require immediate amputation. But, whilst the patient is being examined, and preparations made for the operation, care must be taken that a dangerous quantity of blood be not poured out. This must be prevented by the elevated position and by the application of a tourniquet. For want of this simple precaution, I have seen very large and even fatal quantities of blood gradually lost, by being allowed slowly to trickle from the wound.

In these cases it has been proposed, by some surgeons of great eminence, to enlarge the wound in the limb, or to make an incision down to the fracture, and attempt to tie the artery where it has been injured. It is easy to give, but difficult to carry out, such precepts as these. In most cases they are scarcely practicable, as the surgeon would have to grope in the midst of bleeding and infiltrated tissues, and would experience the greatest possible difficulty in finding the wounded vessel, after a search which would materially tend to increase the disorganization of the limb. Even after the removal of a limb in this condition, it is often by no means easy to find the artery that has poured out blood; and how much more difficult must it not be to search for it successfully during life?

The ligature of the artery at a higher point of the limb does not hold out much prospect of success, for the same reasons that render its employment inadmissible in ordinary wounds of arteries. If, then, proper means directed to the wound, such as position, pressure, or perhaps the attempt at ligature if the artery can be easily reached, be not successful, no course is left to the surgeon but to amputate the limb without delay. This is more especially the case if it be the lower extremity that is injured: in the arm, there is a better prospect of our being able to arrest the bleeding without having recourse to this extreme measure.

4. *Comminution or splintering of the broken bone* is always a serious complication of a compound fracture. Here the case is very different from what occurs under similar circumstances in a simple fracture. Extensive suppuration will set in: the splinters, if completely or nearly detached, will lose their vitality, and not only produce all the irritation that would result from the inclusion of rough and pointed foreign bodies in the interior of a limb, but, if numerous, will, on their removal or separation, leave the member in a shortened and permanently deformed state. The treatment of such cases will depend on the seat of the injury, and the extent of the comminution. Compound and comminuted fractures of the femur, may, except when occurring in the upper third, generally be looked upon as cases for immediate amputation (*vide* pp. 148–49); the only other exceptions being when the comminution is trivial, the splinters large, lying in the axis of the bone, and the subject young. In the arm, forearm, and hand, and in the leg, provided the knee and ankle-joints be not involved, much may be done in the way of removal of splinters of detached bone, and in sawing off smoothly the rugged ends of the fixed fragments. The larger attached and "tertiary" should be left, as they will throw out callus, and become buttresses of support to the broken bone (*vide* p. 146). If a considerable quantity of splintered bone have been extracted from a limb, care must be taken that in putting up the fracture too complete extension is not main-

tained, lest a gap be left, which cannot be filled up by callus, and a weakened limb result. It is better to place the bones in proper apposition, and to let the patient recover with a shortened but strong and otherwise useful limb.

5. The complication of a *bad compound fracture requiring amputation low down in a limb, with a simple fracture high up*, is a serious one. The question that will here arise is: Should the amputation be performed above the compound and below the simple fracture, or above both? The answer to this must depend on the condition of the limb between the fractures. Suppose that there be a badly comminuted and compound fracture of the lower third of the leg, with a simple fracture of the middle of the thigh; or a crush of the hand or forearm, with simple fracture of the middle of the humerus; how should the surgeon act? It appears to me that the proper course to adopt in such a case as this, would mainly depend on the conditions of the intervening soft parts. If these be sound, free from extravasation, not contused or lacerated, the limb may with safety be removed just above the lower fracture, the upper fracture being treated on ordinary principles. But if there be extensive bruising of the limb with ecchymosis or deep extravasation between the fractures, then it would clearly be useless to amputate low down, as not only would the stump have to be formed of tissues in a state of disorganization, but the inflammation set up at the seat of operation would speedily spread into the structures filled by extravasation, and, setting up unhealthy suppuration in these, would spread upwards to the higher fracture, converting it into a compound one of the worst kind. In such cases, therefore, where there is extensive disorganization of the intervening soft parts, it appears to me that the proper course for the surgeon to pursue is to remove the limb at or above the line of the higher fracture.

6. The complication of a *dislocation high up with a bad compound fracture low down*, as when the shoulder is dislocated, and the hand is crushed, is not so serious; the dislocation having been reduced, the limb may be amputated low down with safety. This practice I had occasion to adopt some years since in a young man who met with a bad crush of the hand and forearm, with dislocation of the humerus into the axilla, in consequence of the limb having become entangled in machinery. If, however, the compound fracture, unattended by any of the complications that have just been mentioned, occur in a young or otherwise healthy subject, we must, of course, attempt to save the limb, and shall generally succeed in doing so.

Treatment.—In the management of a compound fracture, more especially of the lower extremity, special apparatus, such as M'Intyre's, Liston's, or the bracket-splints, double inclined planes, swing-boxes, and fracture-beds, are often necessary, in order to obtain access to the wound, so as to dress it properly, and to place the limb in the best position for union. In many cases the starched bandage may very advantageously be used, but it requires caution, as swelling and consequent strangulation of the limb may take place under it.

In the treatment of compound fractures, there are several points that require special attention. These are: 1, the reduction and the management of any protruding bone; 2, the management of splinters; 3, the closure of the wound; and 4, the subduing consecutive inflammation. It is in carrying out these indications that the whole treatment of the injuries is involved, in those cases in which the limb admits of being saved.

The *reduction* of compound fractures must be accomplished with the same attention to gentleness as in that of simple ones. In the majority of cases, no great difficulty is experienced in effecting this; and after it has been done, the limb should be placed on a well-padded splint, properly protected in the neighborhood of the wound with oiled silk, so as to prevent soiling of the pads by blood and discharge. In some cases, however, considerable difficulty arises in the reduction, from the protrusion of one of the broken fragments which has been driven through the skin, either by careless handling of the limb in carrying the patient, or else by the muscular contractions dragging the lower fragment forcibly upwards, and thus causing perforation of the integument. The protruded bone must, if possible, be gently replaced, by relaxing the muscles of the limb, and thus bringing the soft parts over it. Sometimes, however, it is so tightly embraced by the skin, which appears to be doubled in underneath, that enlargement of the wound becomes necessary before it can be replaced. In other cases, again, it will be found that reduction cannot be effected or maintained, unless the sharp and projecting point of bone be sawn off. This is best done with an ordinary amputating saw, the neighboring soft parts

being protected with a split card; or else by passing the blade of a Butcher's saw under the bone and cutting upwards. The limb, as I have found in several cases in which it has been necessary to have recourse to this procedure, is not ultimately weakened or necessarily shortened by it.

After the reduction, the great object is, if possible, to convert the compound into a simple fracture by the *closure of the external wound.* No pains should be neglected to effect this desirable end. If it can be accomplished, the tediousness and danger of the case are greatly lessened; the whole process of suppuration, with all its attendant evils, being saved to the patient. But the chance of closing the wound in the soft parts will vary greatly in different cases, depending chiefly on the way in which it has been produced, whether by transfixion of the skin by the sharp angular fragment, or by the direct violence which has occasioned the fracture. In fact, the more the wound partakes of a clean cut, the greater the probability of its closure by the first intention; the more contused it is, the greater the certainty of its suppuration. It appears to me that nothing can be more useless or more unsurgical, than to endeavor to close the wound in the latter circumstances. If the wound be small, clean cut, and occasioned by the protrusion of the fragment rather than by the direct violence which occasions the fracture, we may hope to succeed in our object by following Sir A. Cooper's recommendation of applying to it a piece of lint soaked in its blood, or, what is better, saturated with collodion, and thus obtaining union by direct adhesion. The dressing should be left undisturbed until it loosens of itself, at the end of a week or two, when the wound will probably be found to be closed. With the double object of closing the wound and of preventing decomposition by the entrance of organisms floating in the air, Professor Lister recommends the use of paste made of carbolic acid and whitening, instead of blood or collodion. If the wound be large and lacerated, if a joint have been opened, if the wound have been inflicted by the same violence that has broken the bone, or if there be much bruising of the edges and surrounding tissues, with extravasation into the limb, suppuration must necessarily ensue, and thus direct union cannot be expected to take place. In these circumstances, it is in accordance with the best principles of surgery, not to follow the routine practice of attempting to close the wound, which cannot possibly unite by the first intention, but to treat it like any other contused wound, and apply water-dressing from the very first, so as to allow a vent for the discharges that will take place after the first four-and-twenty hours. If these be retained in the limb by the external wound being kept closed by means of a pad of lint, rendered impervious by dried blood or collodion, deep infiltration of the areolar inter-muscular planes will ensue, with much local tension and purulent infiltration, accompanied by severe constitutional irritation, followed probably by pyæmia. It is, I believe, in consequence of the free vent thus afforded to the discharges, and to their retention being avoided, that many of the worst-looking cases of compound fracture—especially of the leg—those in which there has been extensive sloughing of the soft parts around the wound, with exposure of the fractured fragments, eventually do the best. The danger in such cases is a remote one, from hectic and exhaustion; not an immediate and grave one, from erysipelas and purulent absorption.

After the position of the limb has been thus attended to, an endeavor must be made to *moderate the local inflammatory action*, and to *lessen constitutional irritation.* This is best effected by leaving the part undisturbed and untouched as long as possible. The great art in the successful treatment of compound fractures consists in not disturbing the limb or meddling with the wound. For days, or even weeks the limb may sometimes advantageously be left without interference, when once it has been carefully put up. Should, however, much swelling have taken place, and the wound show no disposition to heal by the first intention, but become inflamed and sloughy, and should much inflammatory action be set up in the limb, this may be moderated by the use of irrigation (Fig. 52), and by the application of cold evaporating lotions. The part should be elevated and but lightly covered, the bedclothes being well raised by means of a cradle, so as not to press on the limb, and to allow space for the evaporation of the cold lotion; care being taken, at the same time, that the bandages be applied very loosely, merely with a sufficient degree of force to retain the limb upon the splint, as inflammatory infiltration, that might rapidly induce strangulation of the part, is apt to ensue. The constitutional irritation must be subdued by the administration of opiates, together with an aperient,

on the morning following the accident; and these medicines must be repeated from time to time during the first few days. Moderate antiphlogistic regimen must be employed, and the patient be disturbed as little as possible. In many cases suppuration rapidly sets in, and, if the patient be addicted to drinking, the constitutional disturbance soon assumes the irritative form: in these circumstances, it is of great moment that support, and even stimulants, be freely given; they must be allowed from the very first, and increased in proportion to the depression of the patient's strength, or as symptoms of nervous irritation come on.

If there be much extravasation of blood into and bruising of the soft parts, great tension of the limb, followed by unhealthy suppuration and sloughing, will take place in the neighborhood of the wound; free incisions are then required to remove the tension and strangulation of the tissues, and, by letting out the broken down blood and pus, to lessen the risk of the occurrence of gangrene. It is in these cases that so much injury results from blindly following, as a routine practice in all cases indiscriminately, the treatment which is undoubtedly of the highest value in some; viz., that of keeping a pad that has become hard and impermeable by imbibition of dried blood over the wound, with a view to its closure by the first intention. The natural vent to the discharge through the external opening being interfered with, deep infiltration takes place through the areolar planes of the limb, and the most extensive local mischief may result, pyæmia being almost certain to ensue. As soon as suppuration is fairly established, a light poultice or thick water-dressing should be applied, and the burrowing of matter prevented by making counter-openings where necessary, by the application of a compress, and by attention to the position of the limb. The fracture apparatus must be kept scrupulously clean, especially in summer; the bandages changed as often as soiled, and the pads well protected with oiled silk. During this period various complications, such as erysipelas, inflammation of the absorbents and veins, and low forms of pneumonia, are apt to occur, requiring special consideration and treatment; so also, if the discharge be abundant, hectic, with its sweats and gastro-intestinal irritation, may come on, requiring full support of the powers of the system, and the administration of the mineral acids and other remedies, according to circumstances. As the confinement to bed is necessarily very prolonged in these cases, often extending through many weeks and months, the state of the patient's back should be attended to, and he should early be placed upon a water-cushion, or hydrostatic bed, lest sores supervene. As the wound gradually heals, water-dressing must be substituted for poultices, so as not to sodden the parts and encourage suppuration, and, in time, the red or blue wash for the water-dressing. The bone will often be observed lying white and bare, bathed in pus, at the bottom of the wound. But even in this apparently unfavorable condition, it may recover itself: lymph gradually being deposited in points on its surface by the action of its own vessels, and becoming vascularized, so as to cover it with a layer of florid granulations; in other cases, necrosis to a greater or less extent will take place, and perfect consolidation does not occur until the bone has separated. Mr. Curling has shown that those portions of necrosed bone are slowest in detaching themselves, which are connected with the lower fragment. In some instances a large quantity of provisional callus is thrown out, in which the necrosed bone is implicated; and then the process of separation becomes extremely tedious and protracted, and amputation may not uncommonly become necessary, from the powers of the patient being unable to bear up in so prolonged a struggle. So soon as some consolidation has taken place, the limb should be firmly put up in gutta-percha or leather splints, with a starched bandage, so as to enable the patient to be taken out of bed, to change the air of his room, and thus to keep up his general health. In fitting these splints, care must be taken to make an aperture opposite the wound, through which it may be dressed (Fig. 104).

The time required for the proper consolidation of a compound fracture varies greatly, according to the amount of injury done to the bones and soft parts, and the age and constitution of the patient. In the most favorable circumstances, it requires double or treble the time that is necessary for the union of a simple fracture. Much stiffness of the limb from rigidity of the muscles and tendons will continue for a considerable length of time; this may gradually be removed by frictions and douches.

Secondary amputation may become necessary from the occurrence of traumatic gangrene, and then it must be done in accordance with the principles already laid

down when speaking of that operation; but more frequently it is required from failure of the powers of the patient in consequence of irritative and asthenic fever, induced by the general disorganization of the limb, or by hectic resulting from profuse suppuration and slow necrosis of the bones. In these circumstances, the constitution suffers from the local irritation which is the source of the wasting discharge; but, by removing this in time, and seizing an interval in which constitutional action may have been somewhat lessened, the patient's life will in all probability be preserved; the results of secondary amputation for compound fracture in these conditions being by no means unfavorable. Indeed, it is remarkable to see how speedily the constitutional irritative and hectic symptoms subside after the removal of the source of irritation; the patient often sleeping well, and taking his food with appetite the day after the operation.

The proper period to seize for the performance of secondary amputation in the earlier stages of the injury is often a most critical point. As a general rule, it may be stated that, if the limb be not removed during the first twenty-four hours, eight or ten days must be allowed to elapse before the operation is done; as during that time constitutional irritation and suppurative fever are of too general and active a character to render fresh shock to the system admissible. But when once the actions appear to tend to localize themselves, the suppuration becoming more abundant, the redness extending but slowly, and the constitutional symptoms merging into an asthenic form, then the limb may be removed with the best prospect of success; the more the action is localized, the better is the chance of the operation succeeding.

In many cases the symptomatic and suppurative fever so rapidly merges into the asthenic form, that the surgeon must seize the best moment he can for the performance of the amputation. In these circumstances the operation is seldom very successful; the stump becomes sloughy, erysipelas or diffuse inflammation of the areolar tissue comes on, or symptoms of pyæmia set in, and the patient speedily dies. In other cases again, there is a marked interval between the stages of the inflammatory and suppurative fever and the supervention of the typhoid symptoms, lasting for twelve or twenty-four hours, or even longer. During this, the mischief may be looked upon as in a great measure of local character; the constitution has been disturbed by the setting up of the inflammatory action, but, this having terminated in suppuration, it has not yet become seriously depressed by the continued irritation of the discharge from the injured limb, or poisoned by the absorption of morbid matters from it.

The patient's powers must not, however, be allowed to sink to the last ebb before amputation is performed; as then, if the shock do not destroy life, intercurrent and visceral congestion, or some low form of inflammatory mischief, will not improbably prove fatal. Much as "conservative" surgery is to be admired and cultivated, and hasty or unnecessary operations to be deprecated, I cannot but think that the life of the patient is occasionally jeopardized, and even lost by disinclination on the part of the surgeon to operate sufficiently early in cases of compound fracture, and by too prolonged attempts at saving the injured limb.

The success of the operation will in a great measure depend upon the after-treatment of the case. Large quantities of stimulants and support are often required in London practice to prevent the patient from sinking. I have frequently given with the best success eight or ten ounces of brandy, twelve or sixteen of port wine, with two or three pints of porter, in the twenty-four hours after these operations, with beef-tea, arrowroot, or meat, if the patient would take it, and have found it absolutely necessary to do so lest death take place from exhaustion.

At a later period than this, when some weeks or months have elapsed, and the fracture has not united, the bones are necrosing, and the patient is being worn out by hectic, amputation must be performed at any convenient moment, and is often done with great success if it be not deferred till too late; for here the mischief is entirely local, and the constitution, suffering only by the debility resulting from it, quickly rallies when the cause of this is removed.

Bending, Rebreaking, and Resetting Bones.—It often happens that a bone which does not appear to have been very skilfully set, and which presents a certain amount of deformity when the splints or apparatus covering it are removed, gradually regains its proper shape if left to itself. This it does by the muscles of the limb moulding the callus whilst still somewhat soft and yielding into a proper shape. The callus may be quite strong enough to bear the weight and to maintain the

length of the limb in its full integrity after the removal of all apparatus, and yet be sufficiently yielding to become slowly and gradually shaped by the action of the muscles of the limb when they are left untrammelled by bandages.

It not unfrequently happens, that at the end of two or three weeks a fractured bone is found in a position too faulty to be remedied by the natural process just described. At this period the bond of union is soft and yielding, and the displacement, if angular, may usually be remedied by frequent readjustment of the apparatus, and more particularly by bandaging the fractured fragments in opposite directions, or by the use of pads and pressure thus exercised on the extremities of the broken bones. If this period be allowed to pass by, and the fracture be allowed to become consolidated, it may be found to be so *badly set* that it becomes necessary to forcibly bend or break the callus, in order to improve the condition of the limb. When the displacement is angular, and the consolidation not very firm, as is usually the case, this may be done readily enough; but if the displacement be longitudinal, and much time have elapsed since the occurrence of the injury, it will be difficult, if not impossible, to remove the deformity. The bending or breaking of the callus is best done under the influence of chloroform; the fracture being then put up again, speedy and perfect consolidation will ensue. In this way I have several times remedied a faulty position in fractured bones, although from six to ten weeks had elapsed from the occurrence of the injury.

Delayed Union.—Occasionally, more particularly in cases of fracture of the femur, tibia, and humerus, the union between the broken fragments is *delayed* several weeks beyond the usual period of perfect consolidation. This arises, in the majority of cases, from constitutional debility, rather than from local causes. When it is found at the expiration of six or eight weeks after the occurrence of simple fracture that the callus is still yielding, the general health should be improved by tonics, change of air, &c., and the limb securely put up in starched or plaster of Paris bandages. Indeed, I believe that delayed union is much less likely to occur in patients who have from the first been treated by the starched bandage, and allowed to move about, than in those who have been confined to bed or rather to the house in the ordinary way.

Ununited Fractures and False Joints.—Some bones, when broken, never unite by callus or plastic matter, their fragments merely being kept firm by the intervention of the aponeurotic structures of the part, as is the case with the patella. This, which is owing to a want of apposition of the fragments, and is dependent on the condition of the part, cannot be considered a diseased action.

It occasionally happens, however, in fractures of the shafts or of the articular ends of long bones, that proper union has not taken place at the usual time, or does not take place at all. This may be owing to one of three circumstances. 1. No uniting material of a stronger kind than fibro-cellular tissue has been formed; 2. The plastic matter that has been thrown out has only developed into fibrous tissue, not having undergone osseous transformation; or, 3, True bony union has taken place, but, owing to some peculiar state of the patient's health, the callus has become absorbed, and the fracture loosened.

In the first and third conditions we have an *ununited fracture;* the ends of the bone, which are rounded and eburnated, being merely connected by, and enveloped in, a loose fibro-cellular tissue.

In the second condition we have a *false joint*, the ends of the bone being tied together by strong fibrous bands. The structure of these false joints, which has been carefully studied by Rokitansky, presents two distinct varieties. In the first, which partakes of the character of a hinge-joint, we find that the ends of the fracture are smoothed and rounded, invested with a dense fibrous periosteum, and united to one another by thick bands of ligamentous tissue, in such a way as usually to admit of considerable lateral movement, though sometimes they are tolerably firm. In the other variety the joint partakes of the ball-and-socket character, usually to a very imperfect degree, but sometimes in a sufficiently well-developed manner, one end of the bone being rounded and invested by periosteum, the other cup-shaped, and covered by firm smooth fibroid tissue. The bones are united by a kind of capsule, in which a synovial-like fluid has occasionally been found.

The form that the false joint will assume depends on the action of the muscles which influence it. Thus, when occurring in the shafts of long bones, where it is subjected to movements of flexion and extension, it will assume the hinge form;

whilst, when it is seated in the articular ends, where it is more subjected to movements of rotation, it will affect the ball-and-socket character.

Causes.—The causes of ununited fracture and of false joint are *constitutional* and *local.*

In some cases the *constitutional cause* appears to be a *cachectic state* of the system occurring from some debilitating disease, such as fever, phthisis, scurvy, or cancer, or from any depressing influence, in consequence of which there is not sufficient reparative power for the production or proper development of the plastic matter, by which the fracture should be united. If this have been deposited, it may, under the influence of these constitutional causes, again become absorbed, and the fractures may thus be loosened. In such cases, on the restoration of the health, union will generally take place. In many cases no constitutional cause for the want of union can be detected, the patient being in excellent health, strong, and robust. In spontaneous fractures, union seldom takes place very readily or perfectly.

Pregnancy is said to have a tendency to interfere with the proper union of a fracture; this, however, I consider doubtful, as I have had under my care, and have seen, a considerable number of cases of fracture in pregnant women, which united in the ordinary time.

Age.—Failure of union in fractures is very rare in children, and when it occurs in them is seldom remediable, unless it be the result of neglect or of improper mechanical treatment. It is common at the earlier, adult, and middle ages. Union will readily occur in aged individuals. Indeed, advanced age appears to exercise no adverse influence on the repair of fractures. I have on two occasions, in my own practice, known very firm and perfect consolidation of fracture of the shaft of the femur to take place in women of ninety years of age and upwards.

The *local causes* are various and important. The *anatomical condition* of the fragments, as regards their *vascular supply*, is perhaps that on which want of union is most immediately dependent. For proper union to take place, it is necessary that the callus be deposited from both sides of the fracture. If one fragment be so situated that sufficient blood is not sent to it for this purpose, not only may want of union, but necrosis, occur. This is exemplified in fractures of the superior articular ends of the humerus and femur. In intra-capsular fracture of the anatomical neck of the humerus, the globular head, being detached from all its vascular connections, may necrose. In intra-capsular fracture of the neck of the femur, the head of the bone, still retaining some vascular connection through the medium of the ligamentum teres, has sufficient blood furnished to it to prevent its death, but not enough to form callus—hence fibrous union takes place. In the shafts of the long bones, the degree of union will be dependent in a great measure on the conditions of the vascular supply to the fragments, through the medium of the nutritious artery. The influence of the rupture of the nutritious artery of the bone by the line of fracture running across it, and thus interfering with the vascular supply of one of the fragments, has been investigated by Gueretin; and the occasional occurrence of atrophy of the bone after fracture, has been shown by Curling to be dependent upon the interruption of the supply of arterial blood through this vessel. Gueretin has collected cases that tend to prove the direct connection between the occurrence of ununited fracture, and the want of proper arterial supply to one of the fragments. Thus, in the humerus the course of the nutritious artery is from above downwards; and of thirteen cases of ununited fracture, nine were found to be situated above the canal in which the vessel is lodged. In the forearm, where the nutritious artery passes from below upwards, of eight cases of ununited fracture, seven occurred below this vessel, and only one above. Mr. Adams has, however, shown that the number and size, as well as position, of the nutrient arteries, vary considerably; and hence the objection that non-union may occur in a fracture of any part of the shaft of a long bone, whereas the nutritious artery is only found at one spot, can scarcely be considered a very valid one. It is certainly owing, in a great measure, to this want of vascular supply to the fragment that intracapsular fractures almost invariably unite by fibrous tissues rather than by bone; and that, when bony union takes place, the callus is chiefly formed by the surface connected with the shaft. In some cases of intracapsular fracture of the humerus, no union whatever takes place, the detached fragment necrosing in consequence of being entirely deprived of its supply of blood.

Some bones are much more liable than others to disunion of their fractures. According to the statistics collected by Norris, it would appear that the femur, the humerus, the bones of the leg, and of the forearm, and lastly the lower jaw, are those in which ununited fractures most frequently occur, and that in the order which has been given.

The occurrence of ununited fracture is occasionally attributed to the *mobility or want of proper apposition* of the fragments, and doubtless in some cases it may be so occasioned; but I believe that these causes are not nearly so frequent in their operation as the constitutional and local conditions that have already been pointed out. The *interposition of a piece of muscle* between the fragments may prevent union. Of this I saw an interesting instance some years ago, in which want of union in a fractured femur was owing to the entanglement of a portion of the rectus muscle between the fragments.

The *treatment of ununited fracture* must not be conducted by local means only; *constitutional measures* should not be neglected. We cannot expect the formation of firm and strong callus unless the general health be in a satisfactory state. If callus have not been formed, or if, after formation, it have been absorbed under the influence of a cachectic state of the system, the improvement of the patient's health, at the same time that the fracture is put up again firmly, so that the ends of the bone are brought into close apposition, may bring about perfect union. I have had under my care at the hospital, a man with ununited fracture of the femur from absorption of the callus four months after the occurrence of the injury, under the influence of incipient phthisis and debility induced by want of food: perfect consolidation of the fracture was produced by giving him cod-liver oil and good diet, with rest in bed and a starched bandage to the limb. Hence it is evident that impaired nutrition may prevent union, even after a fracture has become consolidated, and that improvement of the nutritive activity of the body may of itself lead to consolidation of the fragments. If there be no very evident cause for the want of union, it will occasionally suffice to put up the fracture firmly in leather or gutta-percha splints, with a starched bandage, and then to allow the patient to move about upon crutches, so that his general health may not suffer, at the same time that a tonic plan of treatment is followed. I have seen several cases in which the want of union appeared to have resulted from too long confinement of the patient to his bed, and the consequent impairment of his health, consolidation having taken place when a more favorable hygienic system was enforced. This simple plan can, however, only be useful if but a short time, at most some months, have elapsed from the occurrence of the injury. In some cases, the empirical administration of mercury is attended with success. In a case of united fracture of the humerus that was admitted into the University College Hospital under Mr. Liston, fifteen weeks after the occurrence of the injury, union was induced within a month by putting up the limb in splints, and salivating the patient. When the want of union arises from malignant disease, nothing can be done.

At the same time, with appropriate constitutional treatment, suitable *local means* must be employed to secure steady coaptation of the fragments. In the upper extremity, this may usually be done by means of splints of an ordinary character. In the leg, the starched or plaster of Paris bandage will be found to be especially serviceable. In the case of ununited fracture of the thigh, special apparatus will be required to secure complete fixity and steadiness of the limb. For this purpose, the limb should be put in an apparatus, consisting of an outer and an inner iron rod having hinge-joints opposite the hip and ankle, and attached above to a strong pelvic band, and below to the sole of the boot. The thigh part should be provided with well-padded splints, which may be screwed down in opposite directions against the two fragments, so as to hold them firmly in contact. This instrument should be worn for several months; and by it Dr. Smith, of Philadelphia, has succeeded in curing ten out of fourteen ununited fractures in the lower extremity. One great recommendation is, that this plan of treatment is entirely devoid of danger, and enables the patient to take exercise whilst under treatment. In cases where there is much shortening of the limb and riding of the fragments, which is especially apt to occur in the thigh, it will be necessary to employ extension of the limb as well as compression of the fragments against one another. This extension may be made by the lateral iron rods of the above-described apparatus being constructed so as to slide, and to admit of extension by means of a rack and pinion or screw me-

chanism, adjusted to them, by which the limb may be gradually lengthened to any required extent.

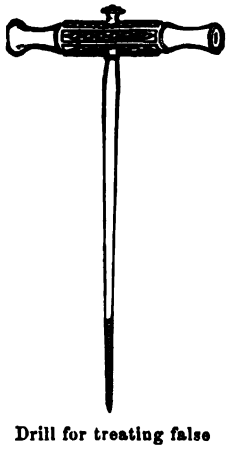
When the failure of union has become very chronic, and a *false joint* has been formed, it will be necessary to employ operative procedure before union can be attained. All operations that are undertaken in these cases are conducted on one of two principles; either, 1, *to excite such inflammation in the false joint* and the neighboring tissues, as will lead to the formation of lymph capable of undergoing osseous transformation; or else, 2, *by removing the false joint altogether*, to convert the case into a recent compound fracture, and to treat it in the same way that such an accident would be managed. It can easily be understood that operative procedures conducted on these principles are of too serious a character to be lightly undertaken, or to be had recourse to until other measures have failed, the mortality following them being, even according to published statistics, considerable, and probably very much greater than has been laid before the profession.

1. Among the first set of operations—those that have in view the *excitation of sufficient inflammation to cause deposit of proper plastic matter*—the simplest procedure consists in the introduction of *acupuncture needles*, or in the *subcutaneous section* of the ligamentous band with a tenotome. In this way I have known union effected in a patient of Mr. Liston's, who had a false joint in the shaft of the femur; though not until after the fracture had been converted into a compound one, and much danger and suffering incurred. Four years after the consolidation of the ununited fracture, the patient was readmitted into the hospital, under my care, with fracture of the same bone two inches lower down than the former injury; on this occasion, union took place in the usual manner and time without any difficulty.

The *introduction of a seton* across the false joint, though occasionally successful, is apt to give rise to dangerous and even fatal consequences, from arterial hemorrhage, erysipelas, diffuse inflammation, and suppuration of the limb. The threads must not be left in beyond a few days, when sufficient action will have been induced. A modification of the seton consists in passing a silver wire around the fracture, and gradually tightening this, so as to cut through the false joint at the same time that inflammatory action is excited in it. In performing this operation, it must be borne in mind that large arterial branches, and even the main trunk, especially in the thigh, may become firmly attached to the callus, so that unless care be taken they may readily be wounded.

Dieffenbach has proposed to excite the requisite degree of inflammation by *driving, with a mallet, three or four conical ivory pegs* into holes bored by means of a gimlet or drill (Fig. 106) in the ends of the fractured bone, which are exposed for this purpose. The soft parts are then to be laid down, and after a few weeks the pegs, which have loosened in consequence of the removal or absorption of their ends, should be taken out. It is not necessary or even desirable to endeavor to pin together the ends of the broken bone, but merely to introduce the pegs into the extremities of both fragments near to the seat of fracture. It is, however, especially in ununited fractures of the humerus, that this can be successfully done, the irritation of the pegs appearing to occasion an effusion of a large quantity of callus sufficient for the consolidation of the fracture. This operation I have practised with great success in several instances of ununited fracture of the humerus. In one case that was recently under my care, there was a false joint at the junction of the upper and middle thirds of the bone, complicated with an elbow anchylosed in the straight position; here, after flexion of the stiff elbow, perfect consolidation of the humerus was effected by the use of five pins. In the ununited fractures of the bones of the leg and forearm, it is also likely to be serviceable, but in the femur not so much so. Indeed, in the cases of ununited fractures of this bone, I have known more failures than successes after this operation.

Fig. 106.



Drill for treating false joint.

[In some cases, simple drilling of the fragments is sufficient to induce union; in others it will be found advisable to pin together the fragments with a drill, which may be left in position as long as thought desirable. Very little irritation is pro-

duced by this bone suture, as it has been termed, and the result in many cases has been most satisfactory. Dr. Bigelow, of Boston, has availed himself of the bone producing function of the periosteum, in conjunction with a modification of the bone suture (using an iron wire instead of a drill), and has succeeded in curing ten out of eleven cases which he has treated by this method.—A.]

2. The operation of *removing the false joint* may be performed by cutting down upon it, and resecting the ends of the bones, or else by destroying the articulation with caustic potass. The excision of a false joint is necessarily a dangerous operation, and by no means a successful one; erysipelas, phlebitis, and diffuse suppuration of the bone occasionally supervening. Of 39 cases collected by Norris, in which the ends of the bones were either resected or scraped, 24 were cured, 7 derived no benefit, and 6 died. In those cases of the operation that are successful, some shortening of the limb must be expected to result; and, if the fracture be very oblique, it would of course be impossible to remove more than a very limited portion of it, and, consequently, very perfect union could scarcely be anticipated. The application of caustics to the exposed bones is so coarse and uncertain a method as to find but little favor amongst surgeons of the present day.

On reviewing the various methods that have been recommended for the re-establishment of union between the separated fragments, it would appear that the excitation of proper inflammatory action by the introduction of the seton, or by driving in ivory pegs, promises the most satisfactory result. It is by no means necessary to remove the fibrous band that intervenes between the fragments in cases of false joint; for, if the proper amount of inflammatory action be set up, this either undergoes osseous transformation, or a sufficient quantity of callus is thrown out around it to consolidate the fracture. If union should fail to be accomplished, and the false joint were situated in the femur or the bones of the leg, the limb might be so useless and cumbersome to the patient, that amputation might be required as a last resource.

CHAPTER XIX.

SPECIAL FRACTURES.

In considering the nature and treatment of fractures of particular bones, we shall at present confine our remarks to fractures of the face, ribs, and extremities. Injuries of the bones of the head and spine derive their principal interest and importance from their complication with lesion of the internal and contained organs; hence the consideration of these will be deferred to special chapters.

FRACTURES OF THE FACE AND RIBS.

Nasal Bones.—These, being thin as well as exposed, are not unfrequently broken. When fractured, they may remain undisplaced, but are more commonly depressed; the ridge of the nose being beaten in. The swelling and ecchymosis that usually attend their fracture render detection difficult, and must be reduced before any treatment is adopted. The bone which is depressed should be raised with the broad end of a director, or by the introduction into the nostril of a pair of polypus forceps, which expand in opening, and push the bone into proper position.

If the *septum* alone be broken, the same treatment must be adopted towards it. Usually, after it has been replaced, the position is maintained; but in some cases, where there is a tendency to sinking of the nostrils, the introduction of a plug into the nares will be required to replace and retain the bones. The hemorrhage, which is usually rather abundant may be stopped by the application of cold; but occasionally the nostrils require plugging. If the *lachrymal bone* be broken together with the nasal, the ductus ad nasum may be obstructed, and the course of the tears diverted. In an injury of this kind, I have seen extensive emphysema of the eye-

lids and forehead occur on the patient attempting to blow his nose. In some cases, the injury inflicted to the nasal bones extends through the ethmoid to the base of the brain, and may thus occasion death. This I have seen happen from a severe blow on the face with a piece of wood.

Malar and Upper Jaw Bones.—These are seldom broken unless great and direct violence have been employed, and their fracture is usually accompanied by external wound, as in gunshot injuries of these parts. More commonly the alveolar processes are detached, and the teeth loosened. The treatment then consists in binding the teeth together with gold wire. In some rare cases, all the bones of the face appear to have been smashed and separated from the skull by the infliction of great violence. Thus, South relates the case of a man who was struck on the face with a handle of a crane, and in whom all the bones were separated and loosened, "feeling like beans in a bag." Vidal records the case of a man, who by a fall from a great height, separated all his facial bones. In fractures of the *zygoma*, the fragments may be driven into the temporal muscle, and produce so much difficulty to mastication as to require removal.

In *gunshot injuries of the face*, there is usually great splintering of the bone. As, however, the vitality of the part is great, necrosis is not so likely to ensue here as elsewhere, and the partially detached and loosened fragments may accordingly be put back into position, and will usually recover themselves. There are, however, two principal dangers in these cases, viz., hemorrhage, either primary or secondary, and abundant fetid muco-puriform discharge. The primary hemorrhage usually ceases spontaneously, or on the application of cold. If secondary, it may be arrested by cold, by plugging, and pressure; or, if continuous, and from deep sources, may possibly require ligature of the carotid. The fetid secretion from these wounds is not only a source of great discomfort to the patient, but of positive danger, as, by its miasmatic effluvia, or by finding its way into the stomach, it may occasion typhoid symptoms. This risk is best obviated by scrupulous attention to cleanliness, by repeated injections with warm water or chlorinated lotions.

Lower Jaw.—This bone is frequently broken, owing to its prominent situation; though its arched shape enables it to resist all but extreme degrees of violence. Fractures of this bone are often compound, sometimes in consequence of external wound, but more frequently from the laceration of the gum causing them to communicate with the external air. Not unfrequently, they are comminuted.

Fracture of the lower jaw may occur in various situations. I have seen it most frequently in the *body of the bone* near the symphysis, extending between the lateral incisor and the canine. The *symphysis* itself is not so commonly fractured, the bone being thick in this situation. The *angle* is more frequently broken. The *coronoid process* can only suffer fracture from the most severe and direct external injury, as from a bullet-wound. The *neck of the condyle* is occasionally broken across.

Fractures near the symphysis are usually vertical. Those near the angle are commonly oblique from before backwards, so that a long spiculum of the outer table is connected with the posterior fragment of the inner table.

These fractures are sometimes double, either symmetrically so, or more frequently one on the side near the symphysis, and the other near the angle.

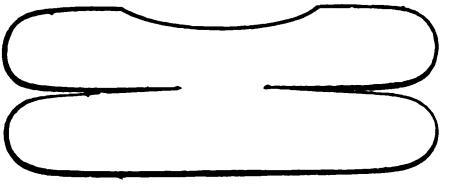
The *signs* of fracture of the lower jaw are very obvious. The great mobility of the fragments, the crepitus, the irregularity of the line of teeth and of the arch of the jaw, laceration of and bleeding from the gums, and dribbling of saliva, indicate unequivocally the nature of the injury. The displacement and mobility of the fracture are greater, the nearer it is to the symphysis. If the bone happen to be broken on both sides of this line, the middle fragment is much dragged out of place by the depressor muscles attached to it; indeed, in all double fractures the displacement is very great. In fracture about the angle and lower part of the ramus, the deformity is not so great, owing to the muscles that coat and protect each side of the bone in this situation preventing the fragments from being displaced. When the neck of the condyle is broken through, that process, coming under the influence of the external pterygoid muscle, is often a great deal displaced.

When the fracture is near the symphysis, the dental canal necessarily escapes; but when it is further back in the body of the bone, and especially near the angle, the canal must necessarily be implicated. It is remarkable, however, that the inferior dental nerve usually escapes injury or division in many cases altogether, in

others for several days, until perhaps, owing to great displacement or to some effort of reduction, it may be torn across. When this happens, the soft parts of the lower lip, supplied by the submental branches, are necessarily for a time paralyzed, but they soon recover. I have never known any permanent mischief from this cause, or from the hemorrhage following laceration of the inferior dental artery.

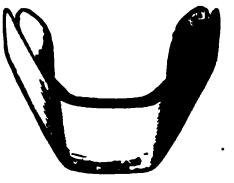
The *treatment* is simple enough in principle, though often not very easy of accomplishment. It consists in maintaining the parts in apposition by suitable apparatus for four or five weeks, during which time mastication must be interdicted, the patient living on sops, soups, and fluid nourishment of all kinds, and talking being prohibited. The apparatus that commonly suffices consists of a gutta-percha splint

Fig. 107.



Gutta-percha splint: Original shape.

Fig. 108.



Gutta-percha splint, moulded to shape of jaw.

(Fig. 107) moulded to the part (Fig. 108), properly padded, and fixed on with a four-tailed bandage; the two fore-ends of which are tied behind the neck, whilst the other two are knotted over the top of the head (Fig. 109). When the ramus is broken, the side of the paste-board cup splint should be made proportionately long. The teeth in these cases require special attention. Any that are loosened must be left in, as they will soon contract adhesions, and fix themselves firmly; and, if necessary, they may be tied to the sound teeth with silver wire, or dentists' silk. But although metallic wire is occasionally needed for the purpose of securing loosened teeth, it is of no service in tying together the teeth for the purpose of more accurately fixing the broken fragments. Care must be taken that any tooth that may have been forced out of its alveolus and dropped between the fragments be removed from this situation; as, in one case where a tooth was overlooked in this position, no union of the fracture took place till it had been removed. When depression, especially near the symphysis, is considerable, a clamp apparatus which fixes the chin and line of teeth, invented by Lonsdale, answers the purpose of steadying the fragments extremely well. When the fracture is double, one fissure occurring near the symphysis, the other near the angle, there is often very considerable difficulty in bringing the fragments into anything like good position without the aid of some special apparatus. In such cases a metal plate should be accurately moulded and fitted to the teeth, and attached to Lonsdale's clamp or to a stem, and fixed to a horseshoe shaped gutta-percha splint placed under the jaw, so as to keep the whole steady and solid. Union generally takes place readily and very perfectly in fractures of the jaw, though it is somewhat slow at first, and the fragments continue mobile for some weeks. But the vascular supply of the bone is abundant, and reparative action correspondingly perfect.

Fig. 109.

Apparatus applied to fracture of lower jaw.

[The usual mode of treating fractures of the lower jaw, in this country, is by the use of a simple compress below the chin, with the Barton's or Gibson's bandage. In applying Barton's bandage it is well to make an additional turn around the forehead, so as to prevent the vertical turns of the bandage from slipping forwards. Velpeau treated most cases of fractured jaw without any apparatus whatever, believing that the pain of the injury was sufficient to check any deleterious movement. (*Amer. Journ. Med. Sciences* for Oct. 1867, p. 514.)—A.]

In *fractures of the body of the lower jaw by gunshot injury*, there is great comminution and splintering of the bone, followed by copious and fetid discharge, which being in part swallowed, may reduce the patient to a state of extreme debility or

induce symptoms of a typhoid character, which may prove fatal. In these cases, Dupuytren recommends the lower lip to be cut through, the splinters taken away, and, if necessary, a portion of the bone resected, so as to convert the wound into one similar to what results after the partial removal of the lower jaw for disease of the bone.

Fracture of the hyoid bone is of very rare occurrence; and, though usually the result of direct violence, as a forcible grasp, has been seen by Ollivier D'Angers to occur from muscular action. The signs are always very obvious. The fragments form a sharp salient angle: there is much pain and irritation, increased by speaking and deglutition. There is usually salivation; and considerable difficulty in breathing may be present. *Reduction* is accomplished by pressing the fragments into apposition, either externally or by passing the finger into the mouth. Should one piece of the bone be driven much in, it might possibly require to be drawn forwards with a tenaculum. The head should then be fixed with a stiff pasteboard collar to prevent displacement.

Fracture of the Ribs and Costal Cartilages.—These injuries commonly arise from direct violence, the part that is struck being driven in towards the thoracic cavity, and thus broken. In other cases, the fracture occurs from indirect violence, the forepart of the chest being forcibly compressed, so that the rib is bent outwards, and thus snaps. When the injury is the result of direct violence, the pleura, lung, liver, or diaphragm, may be wounded, thus giving rise to the most serious and fatal consequences, such as hemorrhage, emphysema, and inflammation of the parts injured. When it is occasioned by indirect violence, the thoracic organs may be contused and thus injured; although, as the fracture takes place in a direction outwards, they are not, in the circumstances, liable to be punctured by the fragments. In some rare cases the ribs have been known to be broken by the violent contraction of the abdominal muscles during parturient efforts. Fractures of the ribs may be *single*, one only being broken; *multiple*, several, or even the whole of the ribs on one side, or several on both sides being fractured; *simple*, as in ordinary violence; and *compound*, as in gunshot injuries.

Any one of the ribs may be broken, and frequently several are fractured at the same time. The middle true ribs are those that most frequently give way, being most exposed, and at the same time fixed. The first and second ribs are seldom broken, being protected by the clavicle and shoulder; when they are fractured, the injury is always very dangerous, on account of the importance of the subjacent structures. The lower ribs, being less firmly fixed than the others, commonly escape, unless very great and direct violence be inflicted upon them. Any part of a rib may be broken by direct violence; but when the fracture is the result of compression of the chest, it is usually the convexity or the neighborhood of the angle of the rib that gives way. These fractures most commonly occur in elderly people, in whom the elasticity of the thoracic parietes has lessened as the result of age.

Symptoms.—The chief symptom complained of is a sharp pricking and catching pain at the seat of injury, increased by breathing deeply, or by coughing. In order to avoid this, the inspirations are shallow, and the breathing is principally diaphragmatic and abdominal. On laying the hand over the seat of injury, and desiring the patient to cough, crepitus may often be felt; and in most cases this is audible on applying the ear to the chest. Occasionally the outline of the rib will be found to be irregular; and in some instances, where several ribs are broken, the whole side of the chest is flattened and depressed. Besides these local symptoms, special phenomena resulting from the complication of wound or laceration of the pleura or lung, such as spitting of blood, pneumothorax, or emphysema, may occur. These complications occur much less frequently than might *à priori* be supposed, owing to the fracturing force usually causing the rib to bend outwards, and thus to break away from, instead of into the chest. The danger of fractured ribs depends entirely on the thoracic complications, and these will chiefly be occasioned by one of two conditions; either the forcible driving in of the fractured end of one rib, so that the pleura and lung become wounded by the sharp and ragged ends of the fragment; or else by a large number of ribs being broken by a severe squeeze of the chest, and the thoracic organs injured by the general compression they thus sustain. It is surprising, however, what an extent of injury may take place in this way, and yet no serious consequences ensue. I have had under my care a young man who, in consequence of a crush of the chest in a railway accident, had the upper seven

ribs broken on the right side, and the lower five on the left, the chest, especially on the right side, being greatly flattened, but who recovered without a bad symptom. In gunshot injuries of the chest, with splintering of the ribs, there is always wound of the contained organs, which becomes the main source of attention on the part of the surgeon.

Treatment.—In treating fractured ribs, the surgeon need not concern himself so much about the union of the fracture, as about the prevention of pain to the patient in breathing, and of the subsequent occurrence of serious inflammation or other mischief within the chest.

Any displacement that may exist usually remedies itself without the necessity of the surgeon interfering. The chest-wall, even when extensively flattened, gradually expands under the influence of the respiratory movements. If, however, a portion of the rib continue depressed, it had most certainly better be left so; the suggestions that have been made for elevating these fractures by means of sharp hooks and screw-probes, being more likely than the continuance of the depression to occasion serious mischief to the contents of the thorax. In order to prevent undue motion of the broken bone and consequent irritation produced by its puncturing the pleura, or lung, the movements of the injured part of the chest may be restrained by the application of a broad flannel roller, or of a laced napkin round it. Instead of, or in addition to these means, I have for many years past found it more useful to apply a roll of adhesive plaster round the chest. The plaster must be about a foot in width, and should be sufficiently long to make one and a half turns round the body. It should be applied very tightly, and may be left on for ten days or a fortnight, when it may require reapplication. It supports the chest more firmly and evenly than an ordinary bandage, affording the patient great comfort. If the lower ribs be broken, the diaphragm may become inverted by the projection inwards of the fractured bone; and if the plaster and bandage be applied too tightly, spasmodic action of that muscle may ensue, occasioning distressing dyspnœa.

[Instead of applying a single roll of adhesive plaster and enveloping the whole chest, it will be found better to apply numerous overlapping strips, not more than two inches in width, and cut lengthwise as regards the roll of plaster, and to embrace only the affected side of the chest. The object is to immobilize the chest-wall of the *injured* side, and the opposite side should be allowed free room to expand in respiration.—A.]

In gunshot injuries of the chest with splintering of the ribs, all broken spicula of bone must be carefully picked out, and the wound lightly covered with water dressing. In such cases, the grave injuries usually sustained by the intrathoracic organs will absorb the surgeon's attention; and for their treatment I must refer to Chapter XXVI.

The prevention of inflammatory action must be attempted, by the employment of bleeding if necessary; but certainly by the adoption of a spare diet and complete rest. Any complication that may occur, such as emphysema, or inflammation of the lungs or pleura, must be treated in accordance with the principles that will be laid down in speaking of Injuries of the Chest generally.

It occasionally happens that fracture of one or more of the *costal cartilages*, especially the fifth, sixth, seventh, or eighth, is produced by direct violence. They may be separated from their junction with the rib, or broken across the middle. The existence of fracture may be determined by the pain on pressure, mobility and irregularity at the seat of injury. The same treatment is required for this fracture as for a broken rib; the broken cartilage most commonly uniting by a bony callus which surrounds the fractured ends.

Fracture of the Sternum.—The sternum is not often broken. Its fracture can only occur from very severe and direct violence; and when this is applied on the fore part of the chest, the ribs or costal cartilages are more liable to suffer. The elastic support furnished to the sternum by these structures, explains in a great measure the rarity of its fracture. It has been known to be broken, though very rarely, by violent straining muscular efforts during parturition.

Its fractures are always transverse, usually single, but sometimes multiple. I have seen it broken into three nearly equal fragments by a fall from a scaffold.

The displacement of one of the fragments is sometimes considerable; but even if it be not, the very superficial situation of the bone will always enable the surgeon

to judge of the exact nature of the injury it has sustained, the signs of which resemble those of a fractured rib.

The *treatment* must be conducted on the same principles as in a broken rib, and presents nothing deserving of special attention. Indeed, when fracture of the sternum occurs from external violence, it is commonly associated with fracture of the ribs, near the angles; and then the chest-bandage or plaster answers equally for both injuries. Should the sternum be broken during parturition, the patient should be made to sit up in bed, with the shoulders supported and leaning forwards slightly, so as to take off the tension of the abdominal muscles.

[*Longitudinal* fracture of the sternum, though ignored by the author, has been met with in three cases, one observed by Malgaigne, and two quoted by Ploucquet, from Kraemer and from Meyer, respectively. The point of greatest importance in injuries of the sternum, is to determine whether the lesion be really a fracture or merely a case of diastasis or dislocation. In the latter case the posterior ligament is found intact, and the patient, therefore, usually escapes visceral complication. In true fractures the prognosis must be very guarded. The heart has been found to be torn in three instances, and even if the viscera escape injury, mediastinal abscess is more apt to form than in cases of diastasis. The following may be regarded as distinct evidences of the existence of fracture, viz., crepitus, the position of the injury being below the junction of the first and second bones, or the fact of the upper overlapping the lower portion. In diastasis the lower fragment almost always rises in front of the upper, as it is drawn up by the action of the ribs in breathing, while the upper having lost its attachments, remains fixed. Where the injury has resulted from direct violence we can tell whether it be fracture or dislocation from the history. If the force has been exerted on the upper bone, the case is one of diastasis, for fracture has never been known to occur from direct violence exerted on that part: on the other hand, if the force have been exerted on the middle bone of the sternum, the case is almost certainly one of fracture. Where the injury is from indirect violence, the diagnosis is not so clear; if, however, there be no emphysema, hæmoptysis, or other evidence of visceral lesion, we may hope that the injury is merely a diastasis. The sternum has been trephined for mediastinal abscess, but the results of the operation do not warrant its repetition. An interesting paper on luxation of the sternum, by Dr. Brinton, of this city, will be found in the *American Journal of Medical Sciences* for July, 1867, pp. 39–51.—A.]

FRACTURES OF THE UPPER EXTREMITY.

The Clavicle is often broken, for three reasons; first, owing to its exposure to direct violence; secondly, to its action in keeping the shoulder at a proper distance from the trunk, and thus receiving all shocks transmitted through the shoulder in a horizontal direction to the trunk; and thirdly, being the only direct osseous support of the upper extremity, it receives, by transmission through the scapula, every shock that is communicated to the hand when the arm is in an extended position. Notwithstanding its exposure to direct violence, it is comparatively seldom broken by injury so received, but it far more often is fractured by indirect violence, as blows on the shoulder and falls on the hand, which are common causes of fractured clavicle. This bone would be more frequently broken than it is, were it not that it resembles two segments of a circle looking in opposite directions, so as to form an S shape, which admirably enables it to withstand indirect violence.

The clavicle is occasionally fractured by muscular action—more particularly by back-handed blows; when the accident occurs from this cause, it is usually about the middle of the bone, and on the right side.

Fractures from direct violence are usually transverse or comminuted. From indirect violence they are oblique. The latter are attended by much more deformity than the former.

Fractures of this bone in infants and young children are usually transverse, and sometimes the bone is merely bent, or is fractured on one side only. The injury is usually occasioned by falling out of bed. Such accidents are frequently overlooked by careless nurses; but, the child crying whenever the arm is moved, attention is directed to the part, and the surgeon then finds some deformity, with a node-like swelling above the middle of the bone.

Both clavicles are occasionally, though rarely, fractured. In one such case, which

was under my care at University College Hospital, in 1861, the patient, a young man of 20, had sustained this injury, and had twelve ribs broken as well, in a railway accident. Nothwithstanding this serious complication, he made an excellent recovery.

The clavicle may be fractured in three situations. 1. Most frequently the *great convexity* is broken; the bone bending here when pressed upon from its extremity, the curve becoming increased, and at last giving way. This fracture may arise from direct violence, but usually is the result of falls on the hand or shoulder. 2. It may be fractured nearer the acromion, *under the acromio-clavicular and coraco-clavicular ligaments.* 3. Its *tip* may be broken off externally to the outermost point of insertion of the trapezoid ligament, between it and the acromion. These latter two fractures can scarcely occur from indirect, but are almost always the result of direct violence.

The *signs* will depend upon the seat of fracture. When the bone is broken *between the conoid and trapezoid ligaments*, there is little if any displacement, but pain on pressure, some crepitus on moving the shoulders, and slight irregularity in running the finger along the bone. When the fracture is *external to the trapezoid ligaments*, there is a remarkably oblique displacement of the scapular fragment, the articular surface of which is turned forwards and inwards, with a slight inclination downwards, nearly at right angles to the rest of the bone, apparently by the dragging of the weight of the shoulder, the point of which, with the scapula, is rounded forwards (Fig. 111). When the fracture occurs *about the middle of the bone*, or at any part on the *sternal side of the scapular ligaments*, there is a remarkable degree of deformity owing to a triple displacement of the outer fragment inwards, downwards, and slightly backwards. This displacement is owing to two causes, one of which is mechanical and the other muscular. The displacement downwards is owing to the weight of the arm dragging the fragment down. The displacement inwards, with rotation of the shoulder forwards and pointing of the sternal end of the outer fragment backwards, is owing to muscular action, and is due to the action of the muscles that pass from the trunk to the shoulder drawing the scapula and the whole of the upper extremity forwards and inwards towards the mesial line, when the support of the clavicle is removed. The outer extremity of the inner fragment appears to be elevated, the skin being drawn tensely over it; but this is rather owing to the depression of the outer portion of the bone; it is in reality kept fixed by the antagonism between the sterno-cleido-mastoid and great pectoral muscles. [The outer portion of the inner fragment (as shown by M. Anger) is actually elevated by the elasticity of its ligamentous attachments (the weight of the arm being taken off by the act of fracture) and by the action of the sterno-cleido-mastoid muscle.—A.] On looking at a patient with fracture of the clavicle in this situation, the nature of the injury is at once evident. The flattening of the shoulder, with its point approximated towards the sternum; the great prominence formed by the end of the inner fragment, over which the skin is tightly stretched; the sudden depression under this, and the crepitus, which can be easily induced by raising and rotating the shoulder at the same time that the elbow is pressed to the side, indicate in the most unequivocal manner the nature of the injury. The attitude of the patient is remarkable; he sits, leaning his head down to the affected side, so as to relax the muscles, and supports his elbow and forearm in the sound hand, in order to take off the weight of the limb.

Fig. 110.

Healthy clavicle.

Fig. 111.

Fracture of clavicle, outside of trapezoid ligament.

Comminuted fracture of the clavicle from direct violence is often a serious accident, as the subclavian vein and subjacent plexus of nerves, or the upper part of the chest, may be seriously injured. In a case of this kind that was under my care some time since, the subclavian vein was apparently wounded, great extravasation of blood taking place about the shoulder and neck, and the circulation through the veins of the arm being so much interfered with as to threaten gangrene. The case, however, did perfectly well under the continuous application of arnica lotions to the shoulder, and attention to the position of the arm.

Treatment.—There are few fractures for the cure of which so great a variety of

ingenious and complicated contrivances has been devised, as those of the clavicle, and there are few in which so much ingenuity has been displayed in vain; for, however perfect the apparatus may appear to be, it seldom answers the purpose in view, viz., to cure the fracture without deformity. I believe that more may be done with a little skill and patience by simple means, than by the most elaborate mechanical contrivances.

When the fracture occurs at the tip of the acromial end of the clavicle, there is little if any linear displacement of the broken bone; and a figure-of-8 bandage round the shoulders, and keeping the arm in a sling, will prevent the tendency to rotation of the shoulder forwards. When the bone is broken underneath the scapulo-clavicular ligaments, there is but little displacement, and the same treatment will suffice.

But when the fracture is situated towards the middle of the bone, or indeed at any point to the inside of these ligaments, then the management is more difficult; and there are three principal indications to be attended to in order to correct the triple displacement of the scapular fragment.

1. By making a fulcrum of a thick wedge-shaped cushion with its broad end upwards in the axilla, and then bringing the elbow closely to the side, the humerus is made to act as a lever and draw the shoulder and the scapular fragment outwards, thus correcting the displacement inwards. 2. By pressing the elbow well backwards, behind the lateral median line of the body, the tendency to rotation forwards of the shoulder is removed. 3. By elevating the shoulder, and taking off the weight of the arm by means of a short sling that passes well under the elbow, the displacement downwards is remedied. By these simple means the triple displacement of the outer fragment is corrected. But the great difficulty consists in keeping the fracture in good position; and when it is oblique, this becomes almost impossible, so that a cure without nodular or angular deformity is very seldom obtained.

[In an elaborate and most philosophical as well as practical paper on the treatment of oblique fracture of the clavicle, Dr. Edward Hartshorne, of this city, maintains "that the scapula *as a whole*, and not the shoulder alone, should be the object of attention to be dealt with in the treatment of fractured clavicle. *The pressure is to be made directly upon the lower blade of the scapula about and just above its angle, behind the chest, not through the humeral articulation by the arm and elbow.* . . . The pad should be discarded from the axilla as doing more harm than good, and failing to maintain extension, in the great majority of cases, no matter how constructed or employed between the humerus and ribs; but a broad and long wedge-shaped pad might be rendered useful as a compress, on the lower blade of the scapula." (*Penna. Hosp. Reports*, vol. ii. pp. 108–142.)—A.]

In applying the necessary apparatus, care must be taken to bandage the fingers separately, to pad the palm of the hand with cotton-wadding, and to apply a roller up the arm as high as the axillary pad. Before applying the roller, the elbow must always be flexed: otherwise undue and dangerous constriction of the arm may occur. The pad should be firm, made of bed-tick stuffed with bran, six inches long, five broad, and three thick at its upper part; the sling must support the elbow, and the hand should be well raised across the chest. In the accompanying figure, the sling does not extend so far towards the elbow as it ought to. It is represented in this way, in order not to conceal the other parts of the apparatus (Fig. 112).

Fig. 112.

Treatment of fractured clavicle.

The elbow must be kept to the side by a few turns of a roller, or by means of a padded belt. In children, in whom these fractures often occur, there is frequently a difficulty in keeping the bandages properly applied; in these circumstances the starched apparatus will be found very useful, care being taken to reapply it as often as it becomes loose, lest deformity result. Fractured clavicles occurring in females, to whom any irregularity of union in this situation would be very annoying, are best treated by keeping the patient in bed for the first two or three weeks. By this plan, which is as old as the days of Hippocrates, I have seen better results than by any other. The limb should be put up as represented in Fig. 112.

When *both* clavicles are broken, the patient should be kept in bed, and the shoulder fixed and drawn backwards by means of a figure-of-8 bandage. In the case already alluded to (p. 256), this could not be borne, owing to the simultaneous fracture of the ribs; but the patient nevertheless made a good recovery with little deformity.

[The following will be found a very satisfactory mode of treating cases of fractured clavicle: The patient is confined to bed, on his back, with a single pillow. The scapula being fixed, as recommended by Dr. Hartshorne, by means of a pad or compress, retained in position by adhesive strips, the arm is laid across the breast in what is known as the Velpeau position, when the fracture will be found to have been reduced. After two or three weeks the patient may be allowed to rise, the arm being supported by a sling. I have recently treated in this way a case of fracture of both clavicles, with extensive fracture of the ribs, and the bones have united without any perceptible deformity. With patients who cannot bear the confinement to bed, the scapula should be fixed in the same manner, and the arm secured in the Velpeau position with adhesive strips or bandages. The apparatus devised by Dr. Fox of this city, or its modification by Dr. Levis, may be made to serve an excellent purpose, by taking care to use the pad *not* as a fulcrum, but as a compress to steady the lower blade of the scapula.—A.]

Fractures of the Scapula.—1. *Fracture of the body of the scapula* is not very commonly met with; and when it occurs, being always the result of considerable direct violence, it is usually associated with serious injury to the subjacent ribs and trunk. The thick layer of muscles overlying this bone not only protects it, but prevents displacement, and renders the detection of its fracture difficult. The fracture usually takes place across the bone, immediately below the spine; but occasionally it may be split longitudinally or starred.

The *treatment* consists in placing the arm in a sling, the application of a body-bandage, and support of the part with a pad. But all surgeons who have seen this accident are agreed as to the extreme difficulty of obtaining union without considerable deformity; which, however, is of less moment here than in most other situations.

Fractures in the vicinity of the shoulder-joint are of common occurrence, and may happen either in the bony points of the scapula that overhang this articulation, or else in the upper end of the humerus. Not unfrequently there is double fracture in the neighborhood of this articulation; thus the acromion may be broken, as well as the neck of the humerus. These complications necessarily throw some difficulty in the way of the diagnosis of these fractures. In many cases, also, the amount of contusion, and the rapid swelling that takes place, obscure the nature of the injury.

2. The *acromion*, forming as it does the very tip of the shoulder, is more frequently broken than any other part of the scapula. But, in spite of its exposed situation, fracture of this process through its base is not a very common accident; at least I have seen but few cases of it, and there is good reason to believe that many of the cases of supposed fracture in this situation are in reality cases of delayed ossification of the line of junction between the base and the epiphysis. Notwithstanding this source of fallacy, there can be no doubt, as is proved by numerous preparations, that this fracture does occur.

The *signs* of this fracture are very obvious. When the acromion is broken off near its root, the arm hangs as a dead weight by the side, and the patient, feeling as if his arm were dropping off, supports it with the other hand. There is flattening of the shoulder, which is most marked when the patient is looked at from behind; and the head of the humerus can be felt somewhat lower in the axilla than natural. On running the finger along the spine of the scapula, a sudden inequality in the line of the bone can be detected; and, on raising the elbow and rotating the arm, crepitus can be felt, the rounded outline of the shoulder being restored.

When the tip only of the acromion is broken off, the nature of the injury may be suspected by the patient being unable to raise his arm to a level with his head, so as to touch the crown, owing to some of the fibres of the deltoid having lost their points of attachment; and it may be determined by the existence in a minor degree of some of the preceding signs, which prevent the accident from being confounded with paralysis of the deltoid from contusion; and especially by the tip being felt to be detached. But, as has already been stated, this may be a congenital defect, to

which perhaps attention has only been directed when the shoulder has been bruised or otherwise injured.

The *treatment* consists principally in raising the elbow, so as to take off the weight of the limb, and to push up the acromion by the head of the humerus. If the extremity only be broken off in front of the acromio-clavicular articulation, a pad may be placed between the elbow and the side, in order to direct the arm somewhat upwards and inwards, and the limb must be fixed in this position by a bandage and sling. Should the fracture have taken place at or behind the line of the clavicular articulation, the treatment must be the same as that for fractured clavicle.

When the base of this process is broken across, there is not much separation between the fragments, and union usually takes place by bone. When the apex is detached, fibroid or ligamentous union generally occurs, the fragments being widely separated.

3. The *coracoid process* is but seldom broken, there not being more than ten or twelve unequivocal cases of this accident recorded. It cannot happen, except by very direct violence. There is in the museum of University College a preparation showing a fracture of the base of this process, implicating and extending through the glenoid cavity, and complicated with fracture across the base of the acromion. The attachment of such powerful muscles as the pectoralis minor, biceps, and coracobrachialis, displaces the fragment considerably, and would do so still more, were it not that it is kept in position by the ligaments to which it gives insertion, and whose fibres are expanded over it.

The only *treatment* that can be adopted is to put the arm in a sling and fix it to the side.

4. *Fracture of the neck of the scapula* immediately behind the glenoid cavity, though often described, and its symptoms even detailed, has never been met with on dissection; and there can be little doubt that Sir A. Cooper and Mr. South are correct in stating that cases so described are, in reality, instances of fracture of the upper end of the humerus. There is, according to Mr. South, no preparation in any museum in London illustrating fracture of the neck of the scapula. Indeed, on looking at the great strength of this portion of the bone, and the way in which it is protected by the other parts about the shoulder, it is difficult to understand how it can be broken, except by gunshot violence.

Fractures of the Humerus.—In studying the fractures of the humerus, we must divide that bone into three parts—the upper articular end, the shaft, and the lower articular end.

1. *Fracture of the upper articular end* of the humerus not unfrequently occurs, constituting an important class of injuries which have been carefully studied by Sir A. Cooper, and more recently by Dr. R. W. Smith, whose work on *fractures* deserves the attentive perusal of every practitioner.

Five kinds of fracture of the humerus are met with in the immediate vicinity of the shoulder-joint. Two of these are *intracapsular*, viz., simple fracture of the anatomical neck, and impacted fracture of this portion of the bone. The remaining three are *extracapsular*, viz., fractures of the surgical neck—simple and impacted; and separation of the great tubercle from the head of the bone.

Intracapsular fracture of the neck of the humerus.—When the fracture occurs at the *anatomical neck*, the head of the bone is detached from the tubercles, a little above or at the line of insertion of the capsule. This fracture is occasioned by severe falls or blows on the shoulder. It cannot result from indirect violence. A fall on the hand or elbow may dislocate the humerus or fracture its shaft, but it cannot break its upper articular end. It is comparatively rare in children, but is frequently met with in adults.

The signs of this injury are by no means very distinct, though much light has been thrown upon them by the labors of R. W. Smith. There is loss of motion in the shoulder, with some swelling and considerable pain, together with some deformity; an irregularity, produced by the upper end of the lower fragment, can be felt towards the inner side of the joint; crepitus is easily produced; and there is, on measurement from the acromion to the olecranon, shortening to the extent of about one-third of an inch.

When this fracture is *impacted*, the upper fragment penetrates the lower one. In consequence of this, the axis of the humerus is directed somewhat inwards towards

the coracoid process; here also some irregular osseous swelling may be detected. The head of the bone can be felt in the glenoid cavity, but is not in the axis of the limb, the elbow projecting slightly from the side, there being at the same time a hollow some little distance under the acromion. There is consequently more deformity about the joint in the impacted than in the simple intracapsular fracture, with the same impairment of motion, but only slight crepitus on firmly grasping the shoulder and rotating the elbow.

In fracture of the anatomical neck of the humerus, the portion of bone broken off is truly a foreign body in the joint, and, being unconnected with any ligamentous structure, may perish, and thus give rise to destruction of the articulation. When this does not take place, it is probable that impaction of the fragment has occurred, and that thus its life is maintained; or it may happen, as R. W. Smith supposes, that its vitality is occasionally preserved in consequence of some partial union being kept up between it and the rest of the bone by untorn shreds of capsule. In either case, the principal reparative efforts are made by the lower fragment, which deposits callus abundantly.

Treatment.—As there is often much swelling from contusion in these cases, evaporating lotions should be had recourse to for a few days. A pad may then be placed in the axilla, and a leather or gutta-percha cap fitted to the shoulder and upper arm, the limb having previously been bandaged. The hand must be supported in a sling, and the elbow fixed to the side. In examining and reducing these intracapsular fractures, no violence should be employed, lest the impaction of the fragment be disturbed, or portions of untorn capsule, on which the ultimate osseous repair of the injury is dependent, be broken through.

Extracapsular fracture of the neck of the humerus.—In this injury, the bone is broken through the *surgical neck*, or that portion which is below the tubercles, but above the insertions of the pectoralis major, latissimus dorsi, teres major, and deltoid muscles. This accident is most frequent in adults, but it may occur in children as well, the separation taking place through the line of junction between the epiphysis and the shaft of the bone. In this fracture there is double displacement; the head of the bone and upper fragment are rotated outwards, being under the influence of the muscles inserted into the great tubercle, whilst the shaft is drawn upwards and inwards and forwards under the coracoid process, by the muscles going from the trunk to the arm, and by the flexors of the limb.

The *signs* of this fracture are sufficiently obvious. The glenoid cavity is filled by the head of the bone, which can be felt in it. Below this there is a depression; crepitus is easily produced, and there is great mobility of the lower fragment, and shortening of the limb to the extent of from three-quarters to one inch; but the most remarkable sign is the prominence formed by the upper end of the shaft of the humerus, which projects under the integuments, and can readily be felt under the coracoid process, especially when the elbow is pushed upwards and rotated. The axis of the bone is also directed obliquely upwards and inwards towards this point. In consequence of the irritation of the nerves of the axillary plexus by this fragment, which is often very sharp and angular, a good deal of pain is complained of in the arm and fingers. This sign, however, is not met with in children, owing to the greater smoothness of the fractured surfaces.

Impacted extracapsular fracture of the neck of the humerus has been especially treated by R. W. Smith in his excellent work on *fractures*. In this injury, the superior fragment being penetrated by the inferior one, the continuity of the bone and its firmness are in a great measure preserved; hence, the usual signs of fracture, such as mobility, displacement, and crepitus, are not readily obtainable, and indeed the signs of this injury are chiefly negative. Thus, there are impairment of motion, slight deformity about the joint and upper part of the arm, and some crepitus; but the latter is only obtainable with difficulty, and by firmly grasping the head of the bone whilst the elbow is being rotated.

The treatment to be adopted in these cases should be carried out in accordance with the following principles and details: 1. To bandage the fingers, hand, and arm so as to prevent congestion and œdema of the limb; 2. To place a pad in the axilla to act as a fulcrum; 3. To bandage the elbow closely to the side so as to overcome the displacement inwards of the upper end of the shaft, which will be thrown outwards by the axillary pad; 4. To carry the elbow (whilst it is being bandaged to the side) forwards across the chest, in advance of the lateral median line, in order to

counteract the forward displacement of the upper end of the shaft, and thus to throw it backwards towards the head of the humerus; 5. To apply a sling so as merely to support the hand and wrist, allowing the elbow to hang unsupported, and thus letting the weight of the arm counteract the displacement upwards (Fig. 113). By these means the triple displacement of the upper end of the shaft outwards, forwards, and upwards will be counteracted. The whole is then to be steadied by means of a leather or gutta-percha cap, carefully moulded and fitted to the shoulder and arm. As the bruising and extravasation are often very considerable in these cases, it is as well to apply evaporating lotions in the first instance.

Fig. 113.

Treatment of fracture of the neck of the humerus.

In the management of some of these fractures, I have found a very convenient apparatus to consist of a leather splint about two feet long by six inches broad, bent upon itself in the middle, so that one-half of it may be applied lengthwise to the chest, and the other half to the inside of the injured arm; the angle formed by the bend, which should be somewhat obtuse, being well pressed up into the axilla. In this way the limb is well steadied, and the tendency to displacement inwards of the lower fragment is corrected.

In some cases, fracture of the neck of the humerus is followed by atrophy of the bone, though good union has taken place.

[Fractures of the surgical neck of the humerus, and indeed of the shaft at any point above its middle, may be conveniently and efficiently treated by simply binding the arm against the chest, a folded towel being interposed to fill up the hollow of the axilla. The arm should be previously bandaged as high as the seat of fracture, and after a week or two a cap of pasteboard may be applied to the external surface of the limb. I have found this method very effectual, and less irksome to the patient than any other.—A.]

Compound fracture of the surgical neck of the humerus is not of common occurrence. I have had a case under my care in which the accident happened to a lad from a fall out of a window. The fracture was transverse, and the upper extremity of the lower fragment was driven upwards, and protruded through the deltoid to the extent of an inch and a half. It was reduced with difficulty: as great irritation was set up around the seat of injury, and as there was a tendency to recurrent protrusion of the upper extremity of the lower fragment, this was turned out by enlarging the wound, and about an inch and a half of it sawn off. Union took place between the fragments, and recovery was effected with a very useful arm.

Separation of the great tubercle of the humerus occasionally occurs from falls and blows upon the shoulder; but more commonly as the result of the violent action of the three external rotator muscles which are inserted into it. In this injury there is a double displacement; the tubercle is carried upwards and outwards away from the head of the bone, and under and external to the acromion process; the head is drawn upwards and inwards by the muscles passing from the trunk to the arm, as well as by the flexors of the arm, in such a way that it lies upon the inner edge of the glenoid cavity under the coracoid process, and is indeed almost luxated. The consequence of this double displacement is a great increase in the breadth of the shoulder, which has nearly double its natural size; on examination, a rounded tumor—the head of the bone—movable on rotating the arm, can be felt under the coracoid process, whilst another osseous mass—the great tubercle—may be felt at the outer and back part of the joint; between these a sulcus is perceptible, and crepitus may be felt by bringing the two portions of bone into apposition and rotating the arm. This accident, which is of rare occurrence, has been most carefully described by Guthrie and Smith, to whom our knowledge of its pathology is due.

The principle of *treatment* consists in an attempt to bring the detached tubercle into contact with the head of the bone, and retain it there; this may be done either by mechanical means, or by relaxation of the muscles.

The treatment by mechanical means consists in placing a pad in the axilla, and bringing the elbow to the side so as to throw out the head of the bone, at the same

time that, by means of a compress, the tubercle is pressed into proper position, the arm being supported in a sling. The treatment by relaxation of the muscles consists in elevating and extending the arm from the trunk; in carrying this out, it is necessary that the patient be confined to bed, the arm being supported on a pillow.

Compound and comminuted fractures of the head of the humerus can only occur as a consequence of gunshot injury. In these cases there may also be splintering of the acromion or coracoid processes, of the neck of the scapula or glenoid cavity, and possibly injury to the axillary vessels and plexus of nerves.

The *treatment* must depend upon the extent of these complications. If the injury be chiefly confined to the head of the humerus, with little damage to the soft parts, and none to the main vessels or nerves, excision should be practised, any splinters in connection with the scapular processes being removed at the same time. Should, however, the soft parts be extensively disorganized, and especially the great vessels and nerves torn, amputation is the sole resource.

2. *Fractures of the shaft of the humerus* are usually somewhat oblique from above, downwards, and outwards. They may occur from any kind of external violence, but are more frequently the result of muscular action than those of any other bone. The nature of the accident can be at once detected by the great mobility of the fragment, the ready production of crepitus, and the other ordinary signs of fracture. The displacement usually consists in the lower fragment being drawn upwards and to the inner side of the upper one, which is often somewhat everted. The *treatment* is of the simplest character; flexing the elbow, bandaging the arm, and the application of two or three well-padded splints, the inner one of which should be rectangular, being all that is necessary. In applying a splint to the inner side of the arm, care must be taken that it do not press upon the axillary vein, lest œdema of the limb occur.

3. *Fractures in the vicinity of the elbow-joint* may occur through any of the osseous prominences in this situation. They are very commonly complicated with dislocation, with considerable contusion of and injury to the joint, or perhaps with comminution of the bones, and considerable laceration of the soft parts covering them. In most cases swelling speedily comes on, tending to obscure materially the nature of the injury. They may be classified as—separation of the lower epiphysis of the humerus; transverse fracture of the lower end of the bone; fracture of either condyle; and to these may be added fracture of the olecranon.

Separation of the lower epiphysis of the humerus in children before its ossification is complete, is by no means an unfrequent accident; the fragment being carried backwards, with the bones of the forearm connected with it, so as to cause considerable displacement posteriorly. In this accident the trochlea is broken off from the condyles which remain *in situ*, and it is this part of the bone that is carried backwards with the forearm. The detached fragment may readily be replaced, but slips out of its position again, with crepitus, as soon as it is left to itself.

Transverse fracture of the lower end of the humerus, just above the condyles, occasionally occurs in adults. In these cases, the displacement backwards of the forearm and lower fragment, the pain and crepitus, indicate the nature of the accident.

Fracture of either condyle of the humerus may arise from blows and falls on the elbow. There is considerable pain about the seat of the injury, but usually not much displacement; unless, as in Fig. 114, there be a transverse fracture of both condyles. Crepitus, however, may readily be felt by rotating the radius, if it be the external condyle that is injured; or by flexing and pronating the forearm, if it be the internal condyle that has been detached.

Fig. 114.

Transverse fracture of condyles of humerus.

The *treatment* of all these injuries must be conducted on very similar principles. The swelling and inflammatory action, which rapidly supervene, usually require local antiphlogistic treatment, and the application of cold lotions, or of irrigation; the arm being flexed, and supported in an easy position on a proper splint. After the subsidence of the swelling, the fractured bone, whatever be the precise nature of the injury, is best maintained in position by being put up in angular splints; the forearm being kept in the mid-state between pronation and supination, and well supported in a sling. It is in these particular fractures that

passive motion, if it ever be employed, may be had recourse to, a tendency to rigidity about the joint being otherwise often left. The motion should be begun in adults at the expiration of a month or five weeks; in children, at the end of three or four weeks after the occurrence of the accident. Union usually takes place readily in these cases. I have, however, seen one instance of an ununited fracture of the external condyle of the humerus in a boy about ten years old.

Compound and comminuted fractures of the elbow-joint are necessarily serious accidents. They are commonly occasioned by falls on the point of the olecranon, which is the process of bone most frequently and extensively fractured. In some cases it will be found that the olecranon escapes injury, whilst the lower epiphysis of the humerus is splintered into many pieces; and more commonly, perhaps, both bones, ulna as well as humerus, are injured. As the integuments over the point of the elbow are thick and hard, very extensive comminution of the bones may occur with very little apparent lesion of the soft parts. When these fractures are the result of gunshot injury, the soft parts may be extensively torn, and the bones greatly shattered. In the cases that occur in civil practice, I have seldom seen much laceration of the soft parts.

The *treatment* of these important accidents will necessarily depend upon the amount of injury done both to bones and to soft parts. If the articulation be simply opened with little laceration of the surrounding soft parts, and no comminution of the fractured bone, the limb may very commonly be preserved by the employment of rest and active antiphlogistic treatment. If the bones be much shattered, the soft parts not being seriously implicated, removal of the splinters and resection of the injured joint will enable the surgeon to save the rest of the limb. But if the soft parts be extensively contused and torn, as well as the bones comminuted, amputation of the arm may be required. If recourse be not had to primary resection, abscess may form in front of or around the joint, with much constitutional disturbance, requiring the removal of the articular osseous extremities in a few weeks, or possibly amputation of the limb. When resection is determined on, whether as a primary or as a secondary operation, the question may arise whether a partial or a complete removal of the articulation should be practised. In these cases, I am decidedly in favor of complete resection; any articular surface that is left covered with an incrusting cartilage interferes very materially with the deposit of lymph necessary for reparative action. Before this can take place, the cartilage must be removed by a process of disintegration, or necrosis of a tedious character, and attended by profuse suppuration. All this is avoided by the complete resection of all the articular surfaces, even where one only is injured. When primary resection is determined on, the sooner the operation is done the better; when a secondary operation is performed, the surgeon must wait until suppuration is fairly established, and then he should do it with as little delay as possible, lest hectic or pyæmia supervene. The operative procedures necessary for the complete resection of a compound and comminuted fracture of the bones that enter into the conformation of the elbow-joint, differ in no material respect from the same operation for disease of the articulation, as will be described in Chapter XLIX.

Fractures of the Forearm.—1. The only fracture of the bones of the forearm that commonly occurs in the vicinity of the elbow-joint, is that of the *olecranon;* this almost invariably happens from falls upon the elbow, and hence is usually accompanied by very considerable bruising and swelling of the parts. It may possibly, though very rarely, from muscular action. The displacement is usually considerable, the fragment which is detached being drawn upwards by the triceps muscle. Occasionally, however, when the ligamentary expansion of the tendon of this muscle is not torn through, there is but little separation of the fragments. In the majority of cases, as the injury takes place from direct violence, there is much swelling about the joint; and not unfrequently the fracture is compound.

The *treatment* is best conducted by straightening the arm, and maintaining it in that position by means of a well-padded light wooden splint laid along its fore part. But, although the arm should be kept straight, it should not be forcibly extended. The best and most easy position in which to put it up is that into which the arm naturally falls when extended. In this there will be seen to be a slight flexion of the elbow. If the forearm be too rigidly extended on the arm, it may be carried backwards beyond the straight line, owing to the loss of the support of the olecranon against the fossa at the back of the humerus.

In *compound* fracture of the olecranon, when an attempt is made to save the joint, and when there is the possibility of anchylosis ensuing, the semiflexed would be preferable to the straight position. In such cases, I have found it most comfortable to the patient to rest his arm slightly bent on a pillow.

Fracture of the coronoid process of the ulna has been supposed by many surgeons to be a common complication, and, indeed, a cause of dislocation of the ulna backwards. There is every reason, however, to believe that this is an error, and that, in point of fact, it is one of the rarest accidents in surgery—at least, we must come to this conclusion, if we are to judge by the small number of recorded cases or of preserved specimens of this injury. Dr. Hamilton states that there are but eight cases on record in which the symptoms led to a belief that this accident had occurred; that in none of these cases were the symptoms unequivocal, but in all open to doubt; and that in not one case did dissection afford an opportunity of positively demonstrating this fracture. There are but four preparations in existence, according to Hamilton, illustrative of this injury, and all these, he says, are of a doubtful character. In the cases in which this accident has been supposed to have occurred, the injury has arisen from falls on the palm of the hand, by which the ulna has been driven backwards, and the coronoid process, striking against the lower end of the humerus, been splintered off. In a case related by Liston, the injury is said to have been produced by muscular action in a boy, who, hanging for a length of time by his hands from a high wall, fell to the ground, and was supposed to have met with this fracture. Whether the fracture actually occurred in this case is doubtful; and, if it did, it is still more doubtful whether it was occasioned by the contraction of the brachialis anticus, or by the violence of the fall.

In the present uncertain state of our knowledge, I forbear to speak of the supposed symptoms of this accident. If it were suspected, the proper treatment would consist in placing the limb in angular splints.

2. *Fractures of the middle of the forearm* are of very common occurrence, both bones being usually broken, with much shortening, angular displacement, and crepitus. Occasionally one bone only is fractured, from the application of direct violence. When this is the case, more attention will be required in establishing the precise nature of the injury.

The *treatment* is simple; a splint somewhat broader than the arm should be placed on each side of it, and a narrow pad laid along the interosseous space, in order that the patency of this may be preserved; no bandage should be placed under the splint. If masses of callus happen to be thrown out across the interosseous space, the prone and supine movements of the hand will be lost, and the utility of the limb greatly interfered with.

[Fractures of the forearm are best treated in the position of extreme supination as originally recommended by Mr. Lonsdale. I have found no difficulty in meeting this indication by means of the two straight splints ordinarily used for these fractures. The size of these splints is a matter of importance: they should be just wide enough to keep the encircling bandage from pressing on the sides of the forearm, and should not be too thickly padded; the position of supination of itself secures the interosseous space from encroachment. The palmar splint should extend from the bend of the elbow to the ends of the fingers, but the dorsal splint from just below the olecranon to the wrist only; if longer than this it is very apt to excoriate the knuckles and back of the hand.—A.]

Compound fractures of the forearm seldom give much trouble or require amputation, but they very commonly lead to obliteration of the interosseous space, and thus impair the after utility of the limb.

3. *Fractures of the lower extremity of the radius*, near the wrist, are of very common occurrence. Their importance, not only in a diagnostic point of view, but also in reference to treatment, has caused them to be carefully studied by surgeons; and their nature and pathology have been specially investigated by Colles, Goyrand, Voillemier, Nélaton, and R. W. Smith.*

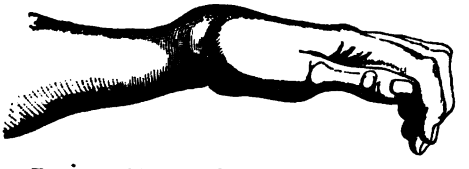
These fractures usually occur from falls upon the palm of the hand, in consequence of which the lower end of the bone is bent back and drawn up; but they may be occasioned by direct violence, or by falls on the dorsum, so that the hand is forcibly bent forwards. In this accident the radius is always broken across transversely, usually from three-quarters to one inch above its articular surface.

* [To these names should be added that of Dr. J. Rhea Barton, of this city.—A.]

The fracture may be of three kinds: 1, a simple transverse one; 2, with comminution of the lower fragment; and 3, with firm impaction of the upper into the lower fragment.

The *signs* of this accident vary greatly, according to its nature. When *simple*, there is usually no very great displacement; but there will be noticed some tumefaction about the wrist, a swelling at its dorsal aspect, loss of the movement of the radius, and crepitus on rotating the bone, whilst the hand is drawn down. When the fracture is *comminuted*, and still more so when *impacted*, the signs are very marked and characteristic; so much so, that they may always be looked upon as diagnostic of those forms of this accident. The deformity thus occasioned gives

Fig. 115.



Fracture of lower end of radius: side view.

Fig. 116.

Fracture of lower end of radius: back view.

rise to a remarkable undular distortion of the wrist. On looking at the injured limb sideways, it will be seen that there is a considerable dorsal prominence apparently situated on the back of the carpus (Fig. 115); immediately underneath this, on the palmar aspect of the wrist, just opposite the annular ligament, there is a remarkable hollow or arch most distinctly marked at, and indeed confined to, the radial side of the arm; a little above this, that is to say, on the lower part of the palmar aspect of the forearm, there is another rounded prominence, not nearly so large or distinct, however, as the one on the dorsal aspect. On looking at the back of the hand, it will be seen to be placed somewhat obliquely to the axis of the forearm; the ulnar border being somewhat convex, and the styloid process of the ulna projecting sharply under the skin (Fig. 116). The radial side of the wrist is, on the contrary, somewhat concave, appearing to be shortened.

The pain about the seat of injury is very severe, and is greatly increased by moving the hand, especially by making any attempt at supination. The hand is perfectly useless, the patient being unable to support it. All power of rotating the radius is lost; the patient moving the whole of the arm from the shoulder at once, and thus apparently, but not really, pronating and supinating it. Crepitus can readily be felt when the fracture is simple or comminuted; but when it is impacted, the most careful examination fails to elicit it.

The *cause of the particular deformity* that is observed, and indeed the general pathology of the injury, has been the subject of much discussion, in a great measure owing, I believe, to the opportunities of dissecting recent fractures of this kind being not very frequent. Surgeons are, however, now generally agreed that the dorsal prominence is due to the lower fragment, carrying the carpus with it, being displaced backwards and upwards; whilst the palmar tumefaction is due to the projection forwards of the lower end of the upper fragment, which is thrown into a state of forcible pronation. There is thus a double cause of displacement in operation. The displacement of the upper fragment is evidently owing to the pronatores quadratus and teres; but to what is the displacement of the lower fragment due? Is it to the peculiar manner in which the two fragments are locked into one another? or is it due to muscular action? Some years ago I had an opportunity of dissecting and carefully examining the state of the limb in a woman who died of paralysis in University College Hospital, twelve days after meeting with this accident. On examining the left arm, which presented all the signs of this injury in a marked degree, and from which Fig. 117 was taken, a transverse fracture of the radius was found about an inch above its articular surface. The lower fragment was split into three portions, between which the upper fragment was

Fig. 117.

Fracture of lower end of radius: Displacement of articular surface.

so firmly impacted to the depth of more than half an inch, as to require some force in its removal. The three portions into which the lower fragment was split were of very unequal size; the two posterior ones being small, consisting merely of scales of bone; the third fragment, the largest, comprising the whole of the articular surface of the radius, which was somewhat tilted upwards and backwards, carrying the hand with it. To this fragment were attached the supinator longus, and the greater part of the pronator quadratus; the ligaments and the capsule of the joint were uninjured.

This case presented the appearances usually met with in this kind of injury; the lower fragment being displaced in such a way that its articular surface looked slightly upwards, backwards, and somewhat outwards, so as to be twisted as it were upon its axis. The upper fragment was found in a state of pronation, and was driven into and firmly impacted in the lower one.

Fig. 118.

Fracture of lower end of radius: Displacement of lower fragment.

That the deformity in this case was the result of impaction, there could be no doubt; and that impaction is the cause of deformity in many cases, is proved by an examination of several specimens of consolidated fracture of the radius preserved in the different collections in London, and by the difficulty of accounting in any other way for the occasional impossibility of properly reducing these fractures. The great traction that is usually required to remove the deformity, and the absence of distinct crepitus until after forcible traction has been employed, indicate the existence of this impaction.

The mode in which the impaction and consequent deformity occur, appears to me to be as follows. When a person falls on the palm of the hand, the shock, which is principally received on the ball of the thumb and the radial side of the wrist, is not directed immediately upwards in the axis of the radius; but the force, impinging in a direction obliquely from before backwards, and from without inwards, as well as from below upwards, has a tendency to rotate the lower fragment on its own axis, and to tilt the articular surface somewhat upwards and outwards. As the upper fragment descends, its posterior surface of compact tissue is forced into the cancellous structure of the lower fragment, to such a depth as will admit of the two anterior portions of compact tissue coming into contact; and thus the upper line of compact tissue is driven into the lower fragment, to an extent corresponding to the degree with which the fragment is rotated upwards and backwards. If the bone be brittle, or the force be continued after this amount of impaction has taken place, the lower fragment will be splintered.

The prominence of the styloid process of the ulna is the result of the shortening of the radial side of the wrist and hand, consequent upon the impaction.

When the fracture is simple, or when it is comminuted without impaction, I agree with R. W. Smith that the displacement of the lower fragment is the result of muscular action. This I have had an opportunity of observing in the following case. A man, 64 years of age, fell to the ground from a height of twenty-five feet. In his fall he broke the left radius just above the wrist, but also met with such serious injuries about the pelvis and abdomen, that he died in an hour after admission into the hospital. On carefully dissecting the arm about twenty-four hours after death, I found that the radius was fractured transversely about half an inch above its lower articular end, and that the lower fragment was completely comminuted. The wrist, which presented all the signs of this fracture in a very marked, but not an extreme degree, could not be restored to its normal shape by any amount of traction that I could employ. On exposing the muscles of the limb, it was found that the supinator longus was attached to the lower, and the pronator quadratus to the upper fragment; the latter muscle being slightly lacerated at its lower part. The upper fragment was strongly pronated. The chief cause of displacement, and the main obstacle to reduction, was found to exist in the two radial extensors of the wrist, the tendons

of which were excessively tense; next to these, the special extensors of the thumb presented most tension, and then the supinator longus, which was far less tense than either of the other sets of muscles, but especially than the radial extensors, the tendons of which were strongly defined. On dividing these tendons, and on pressing the lower end of the upper fragment outwards, reduction was easily effected. Here the displacement was evidently due to two causes. The upper fragment was forcibly pronated by the action of its special pronators; and the hand, with the lower fragment attached, was drawn upwards and backwards by and in the direct line of the radial extensors of the wrist. There was no impaction nor interlocking of fragments, but perfect mobility, and hence muscular action was enabled to come into play.

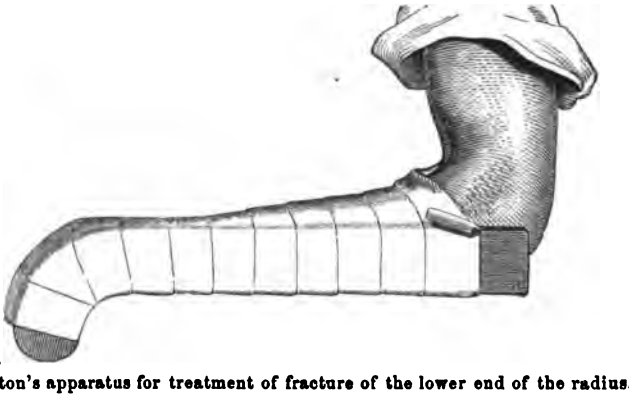
In another case which I have recently dissected, the muscles chiefly at fault were the radial extensors; next to these the extensors of the thumb; the supinators being but slightly if at all contracted.

Besides this injury, R. W. Smith has described a fracture of the lower end of the radius in consequence of falls upon the back of the hand, in which the inferior fragment is displaced forwards. In these cases the character of the deformity indicates the nature of the injury. It can readily be reduced, with a feeling of crepitation, by traction.

In another variety of fracture in this situation, the lower end of the radius and that of the ulna are broken off, resembling very closely dislocation of the wrist backwards. But the facts of the existence of grating, of the ready reduction of the swelling, and of the styloid processes of the radius and of the ulna continuing to be attached to the carpus, and following its movements, will be sufficient to establish the diagnosis.

The *treatment* of the ordinary fracture of the radius near the wrist is best conducted by the apparatus introduced by Nélaton (Fig. 119). This consists of a

Fig. 119.



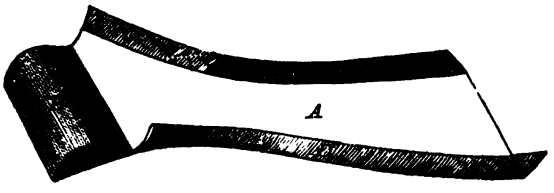
Nélaton's apparatus for treatment of fracture of the lower end of the radius.

pistol-shaped wooden splint, which is placed along the outside of the arm, reaching from the elbow to the extremity of the fingers. Forcible extension and counter-extension should be practised, with the view of disentangling the fragments, and removing the dorsal prominence. The splint, thickly padded opposite the lower fragment, should then be applied to the outer side of the arm; and the hand, being well brought down to its ulnar side, should be bandaged to the bent part of the splint. Another short splint, reaching from the bend of the elbow to the lower extremity of the upper fragment, should now be placed along the inside of the arm, after having been well padded along its radial border, so as to counteract the tendency to pronation of this part of the bone. The arm must then be placed in a sling. When the fracture is impacted, little, if any, alteration in the deformity can be produced. When it is mobile, it may usually be brought into good position. The fracture unites in the course of a month or five weeks. Passive motion of the joint may, however, often be commenced at an earlier period than this, with great advantage to the patient, more particularly when the fracture is impacted. It will be at least three months before the stiffness of the hand and wrist are so far diminished, even by the use of friction and douches, as to enable the patient to use

the fingers. It sometimes happens that in both arms the radius is broken at the same time in this situation, constituting a somewhat serious condition, inasmuch as the patient is not able to feed or assist himself in any way during the treatment.

[Fractures of the lower end of the radius, or of both radius and ulna, may usually be satisfactorily treated on a Bond's splint (Fig. 120). The characteristic deformity may be obviated by the use of compresses (as recommended by Dr. Barton), one over the palmar surface of the upper fragment, and one over the dorsal surface of the lower. The forearm should be kept in a supine position.—A.]

[Fig. 120.



Bond's splint.]

Fractures of the Metacarpus and Fingers are of so simple a character in every way as scarcely to call for detailed remarks. In the *treatment*, rest of the part upon a leather or pasteboard splint is all that is requisite. In compound fracture of these bones, every effort should be made to save the part; if removal become necessary, it should be to as limited an extent as possible (p. 67).

FRACTURES OF THE LOWER EXTREMITY.

Fractures of the Pelvis.—The danger here depends not so much on the extent of the fracture as on its complication with internal injury, and on the violence with which it has been inflicted. Fracture may extend in any direction across the pelvic bones, though most commonly it passes through the rami of the os pubis and ischium, and across the body of the ilium, near the sacro-iliac articulation. In some cases the symphysis is broken through, and in others the fracture extends across the body of the pubic bone.

It occasionally happens that a portion of the crest of the ilium is broken off; but this is of little consequence, even though the bone continue depressed. When the rami of the os pubis and ischium, or the whole body of the ilium, are broken through, there is, of course, considerable danger from internal injury. If the patient escape this, the fracture, however extensive it may be, may unite favorably. A patient, under my care at the hospital, had a fracture extending through the rami of the pubes and ischium in front, and behind across the ilium, in a line parallel with and close to the sacro-iliac symphysis, so as completely to detach one half of the pelvis; he recovered, however, without any bad consequences occurring.

The nature of the injury is usually apparent from the great degree of direct violence that has been inflicted upon the part; from the pain that the patient experiences in moving or in coughing; from the impossibility to stand, in consequence of a feeling as if the body were falling to pieces when he attempts to do so; and from the ready mobility of the part and crepitus on seizing the brim of the pelvis on each side and moving it to and fro, or on rotating the thigh of the affected side. In examining a patient with suspected fracture of the pelvis, care should, however, be taken not to push the investigation too closely, lest injury be inflicted by the movement of the fragments. In those cases, indeed, in which the fracture does not extend completely across the pelvis, or in which it is seated in deeper parts of the ischium, an exact diagnosis may be impossible.

In fractured pelvis, the principal sources of danger arise from injury to the bladder and urethra, with consequent extravasation of urine; from laceration of the rectum, or fracture of the acetabulum; and in examining the pelvis no rough handling should be allowed, lest injury to the pelvic organs be inflicted by the fragments.

In the *treatment*, the first thing to be done is to pass a catheter into the bladder, in order to ascertain the condition of the urinary apparatus; if it be injured, recourse must be had to measures that will be described in speaking of laceration of the urethra. The next thing is to keep the part perfectly quiet, so as to bring about union. With this view, a padded belt, or a broad flannel roller, should be tightly applied round the pelvis, the patient lying on a hard mattress. The knees may then be tied together, and a leather or gutta-percha splint put upon the hip of the side affected, so as to keep the joint quiet, and to prevent all displacement of the frag-

ment. If the urethra have been lacerated, it must be borne in mind that, however completely the patient may recover from the fracture, he will certainly become the subject eventually of the most troublesome and intractable form of urethral stricture—the traumatic.

Fracture of the acetabulum is an accident that can only occur as the result of very great violence directly applied to the hip. It may take place in two situations: either through the floor of the cavity, or only through the rim, a portion of which is detached. It is probably occasioned in most instances by the head of the thigh-bone being driven forcibly against the surface of the acetabulum. Hence, when the rim is broken, it is usually the posterior part that is detached, and the head of the femur slips out upon the dorsum ilii.

Fracture through the floor of the acetabulum is usually complicated with extensive comminution of the pelvic bones and serious internal injury, so as to be followed by death. In the University College Museum is a preparation of a fracture of the acetabulum, with comminution of its floor and of the ilium. Sanson and Sir A. Cooper have seen the bone resolved into its three primitive fragments; and in some cases the comminution has been so great that the head of the femur has been thrust into the pelvic cavity.

In such extensive and grave injuries as these, the surgeon can do little more than support the pelvis with a padded belt, and place the limb on the long splint.

When a portion of the rim of the acetabulum is detached, as the result of direct violence, the head of the femur will slip out upon the dorsum ilii, or into the sciatic notch, and the signs of ilio-sciatic dislocation manifest themselves. In a case of this kind, which was under my care at the hospital in a muscular man about thirty, the shortening, inversion, and displacement of the head of the bone into the sciatic notch, were all well marked and unequivocal. Traction readily effected reduction, with distinct crepitus; but, as soon as extension was discontinued, the head of the bone slipped back into the sciatic notch.

The diagnosis in this case was made, and in similar instances may readily be effected, by attention to three circumstances: the dislocation, its ready reduction with crepitus, and its immediate return when the limb is left to itself.

The *treatment* consists in the application of the long splint with a broad padded belt, so as to secure steadiness of the head of the bone. But with every care a return of displacement will readily take place, and an unsatisfactory result can scarcely be avoided; shortening of the limb, and consequent lameness, being almost inevitable.

Fractures of the Sacrum are excessively rare, except as the result of gunshot injury. When occurring from other causes, such as falls, they are almost invariably associated with fracture of the pelvic bones, and then they have always been fatal. The records of surgery contain but a very few observations, probably not more than six or eight, of uncomplicated fracture of the sacrum arising from other causes than gunshot. I have had two cases of fracture of the sacrum under my care. Both had a rapidly fatal issue. In one there was also fracture through the pubic bone; in the other, the sacrum was the only bone injured. In it, the fracture was the result of a blow on the lower part of the back by the buffer of a railway carriage. The preparation is in the University College Museum. The only other preparation with which I am acquainted, is one in the Museum of the College of Surgeons. These fractures are almost invariably transverse, with displacement forwards of the upper margin of the lower fragment. This was the case in both the instances under my care; but Richerand has published a case in which this bone was split vertically in consequence of a fall on the face; and its crucial and multiple fracture has been described by others. It can necessarily only arise from direct violence of a severe character, attended by much extravasation and pain, together with neuralgia along the course of the posterior sacral nerves, which may be implicated in or irritated by the fracture. The *treatment* would consist in the application of a padded pelvic band.

The Coccyx, though more exposed, is seldom broken. But fracture of it may occur from falls backwards, or from direct blows on the part the tip being bent forcibly forwards, and the elements of the bone separated. The pain in these cases is excessively severe, owing to the bruising of the ligamentous and tendinous expansions that cover the bone. It is greatly increased in sitting and walking, and in defecation. It is sometimes removed on reducing the fractured and displaced frag-

ments by pressure through the rectum, but may continue for months, and even longer, constituting a truly neuralgic affection of the part. South relates the case of a gentleman who broke his coccyx by sitting on the edge of a snuff-box, and who suffered such severe pain that he was obliged to wear a pad on each tuberosity of the ischium, in order that the coccyx might be in a kind of pit, and free from all pressure when he sat.

Under the term *coccydynia*, Sir J. Y. Simpson has described a painful affection of the coccyx and its neighboring structures, which chiefly occurs in women, commonly as the result of injury, and is often of a very severe and persistent character, so as to prevent the patient from sitting, or even walking with comfort. It is an affection that closely resembles in its symptoms the pain occasioned by fissure or ulcer of the anus and rectum. It usually arises from a blow on the part, though it appears sometimes to originate independently of any external violence. The *treatment* recommended by Sir J. Y. Simpson consists in the free subcutaneous division, by means of a tenotome, of the muscular and tendinous structures connected with the coccyx. The section of these structures is made first on one side, then on the other, and finally around the tip, so as completely to isolate the bone. The good effects of the operation are usually immediate, the pain ceasing at once.

Fractures of the Thigh-Bone are of great practical interest, from their frequency and severity. They may occur in the upper articular end of the bone, in its shaft, or in its lower end. In these different situations every possible variety of fracture is often met with.

1. Fractures of the pelvic end of the bone may be divided into those that occur *through the neck within the capsule* of the joint, those that occur *outside the capsule*, and those that implicate the *trochanter* alone.

Intracapsular fractures of the neck of the thigh-bone are of two kinds: the *simple*, in which the bone is merely broken across; and the *impacted*, in which the lower portion of bone is driven into the upper fragment.

This intracapsular fracture may almost be looked upon as a special injury of advanced life, being but seldom met with in persons under fifty. Thus Sir A. Cooper states that, of 251 cases with which he met in the course of his practice, only two were in persons below this age. It may, however, happen at an early period of life. Thus, Mr. Stanley has recorded the case of a lad of eighteen, who met with this injury. Another remarkable circumstance in connection with it is, that it commonly happens from very slight degrees of violence, indeed almost spontaneously. Thus, the jarring of the foot in missing a step in going down stairs, catching the toes under the carpet, tripping upon a stone, or entangling the foot in turning in bed, are sufficient to occasion it. It is especially in women that this injury is met with.

Cause.—The occurrence of this fracture in old age is owing indirectly to the changes in structure, shape, and position of the head and neck of the femur with advancing years. The cancellous structure of these parts becomes expanded, the cells large, loose, and loaded with fluid fat. The compact structure becomes thinned, and proportionately weakened, especially about the middle and under part of the neck, which, appearing to yield to the weight of the body, is shortened; and, instead of being oblique in its direction, becomes horizontal, inserted nearly at a right angle into the shaft. In consequence of these changes in structure and position, it becomes less able to bear any sudden shock by which the weight of the body is thrown upon it, and snaps under the influence of very slight degrees of violence. When it breaks, the capsule may remain uninjured, but the prolongation of it which invests the neck of the bone is usually torn through. In some cases, however, this cervical reflexion is not ruptured, the lower portion of it especially often remaining for some length of time untorn, at last, however, giving way under the influence of the movements of the limb, or by being softened by local inflammatory action. As the violence occasioning the fracture is generally but slight, and as the vascularity of this portion of the bone is trifling in old people, there is but little extravasation of blood.

The fragments are almost always so separated that the fractured surfaces are not in apposition: the upper end of the lower fragment is drawn above and to the outer side of the head of the bone, and at the same time is twisted so that its broken surface looks forwards. The head remains in the acetabulum, attached by the ligamentum teres, and sometimes preserving a connection with the lower fragment, through

the medium of some untorn portions of the fibrous membrane investing the neck. The capsule is uninjured.

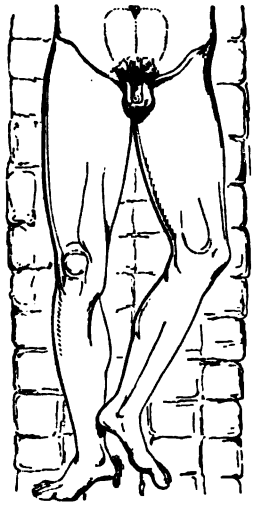
Dr. R. W. Smith has observed, that in some instances the two fragments become interlocked or dovetailed as it were into one another, in consequence of the line of fracture being irregular and dentated.

Signs.—These are, alteration in the shape of the hip, crepitus and pain at the seat of injury, and inability to move the limb, with shortening and eversion of it. These we must consider separately, as important modifications of each are sometimes noticed.

The *alteration in the shape of the hip* is evidenced by some flattening of the part, the trochanter not being so prominent as usual. This process is also approximated to the anterior superior spine of the ilium; and, on rotating the limb, it is felt to move to and fro under the hand, not describing the segment of a circle so distinctly as on the sound side. The circle described by the trochanter on the injured side is much smaller than that on the sound side. In the sound limb, the trochanter describes the segment of a circle having a radius equal to the length of the head and neck of the bone. On the injured side, the circle has a radius equal only to the length of that portion of the neck that still remains attached to the shaft of the bone. During this examination *crepitus* will usually be felt, though this occasionally is very indistinct and even absent, more especially if the limb be not well drawn down at the time it is rotated, so as to bring the fractured surfaces into apposition; and much *pain* is experienced by the patient on any movement of, or pressure upon, the joint.

The *attitude* of the limb is so peculiar, as in general to indicate at once to the surgeon what has happened. There is an appearance of helplessness about it that is striking. As the patient is lying on his back in bed it is everted; shortened somewhat, with the knee semiflexed; on requesting him to lift it up, he makes ineffectual attempts to do so, and at last ends by raising it with the toe of the opposite foot, or with his hands. When he is taken out of bed and placed upright, the injured limb hangs uselessly, with the toes pointing downwards, and the heel raised and pointing to the inner ankle of the sound side, the patient being unable to rest upon it (Fig. 121). In some cases, however, it happens that, after the fracture has occurred, the patient can lift the limb somewhat, but with much exertion, from the couch on which he is lying; or can even manage to walk a few paces, or to stand for a few minutes upon it, with much pain and difficulty. This is owing either to the cervical reflexion of the capsule being untorn, or else to the fragments not being separated, having become locked into one another; and it usually occurs in those cases in which the other and more characteristic signs of this fracture are not well marked.

Fig. 121.



Intracapsular fracture of the neck of the thigh-bone.

Eversion of the limb is almost an invariable accompaniment of this fracture. It is most marked in those cases in which the shortening is most considerable. This eversion has usually been attributed to the action of the external rotator muscles, which are inserted into the upper end of the lower fragment. But I cannot consider this as the only, or indeed the principal cause of this position; for, not only is it very difficult to understand how these muscles can rotate outwards the limb after their centre of motion has been destroyed by the fracture of the neck of the femur, their action being rather in a direction backwards than rotatory under these circumstances, but we find that the limb falls into an everted position in those cases in which, the fracture being in the shaft, and altogether below the insertions of these muscles, no influence can be exercised by them on the lower fragment. I look upon eversion in cases of fractured thigh as not being a muscular action at all, but simply the natural attitude into which the limb falls when left to itself. Even in the sound state, eversion takes place spontaneously whenever muscular action is relaxed, as during sleep, in paralysis, or in the dead body; and in the injured limb, in which there is, as it were, a suspension of muscular action, it will occur equally. Indeed, the shortening

that takes place will specially tend to relax the external rotators, and thus still more prevent their influencing the position of the limb.

Inversion of the foot in cases of intracapsular fracture has been noticed in a few cases. I have seen one instance of this: Smith, Stanley, and other surgeons, also record cases. The cause of this deviation from the usual symptoms of this injury has been a good deal discussed. It has been attributed by some to the cervical ligament not having been torn through at its inner side, but that, as Stanley observes, while it may prevent eversion, cannot occasion inversion; by others to the fact of the lower fragment in these cases being always found in front of the upper one. This circumstance, which is much insisted on by R. W. Smith, appears to me to be rather the result than the cause of the inversion; for any rotation inwards of the lower fragment by the adductor muscles of the thigh would have a tendency to draw the upper end of this fragment to the anterior, or in other words, the inner side of the upper one. I am rather disposed to think that this inversion is owing, in some cases at least, to the external rotators being paralyzed by the violence they receive from the injury that occasions the fracture, and that thus the adductors, acting without antagonists, draw the thigh and leg inwards. In the instance that fell under my observation, and in some of those that have been published, the fracture resulted from direct injury to the hip, and was not occasioned by the patient jarring his foot, or by any indirect violence operating at the end of the limb.

The *shortening* in cases of fracture within the capsule seldom exceeds, in the first instance, from half an inch to an inch, depending on the extent of the separation between the fragments; it cannot, indeed, in the early periods of the fracture, very well exceed the width of the neck of the bone, as the capsule is usually not torn through. After the fracture has existed some time, the capsule of the joint may yield, allowing greater separation between the fragments, and then it may amount to two, or even two and a half inches. It not uncommonly happens that the shortening, which is at first but very slight, about half an inch, suddenly increases to an inch or more; this is accounted for on the supposition of the cervical ligament, which had at first not been completely ruptured, at last giving way entirely; or it may be owing to the fragments which were originally interlocked becoming separated. It is in those cases in which there is but slight separation of the fragments, and consequently little shortening, that the other signs of fracture are not very strongly marked, and that the patient preserves some power over the movements of the limb.

The *constitutional disturbance* in intracapsular fracture of the neck of the femur in old people, though trifling at first, often eventually becomes considerable; and the injury frequently terminates fatally, from the supervention of congestive pneumonia, an asthenic state of system, or sloughing of the nates from confinement to bed during treatment. Hence this injury must always be considered as one of a very dangerous, and not unfrequently fatal character.

Mode of Union.—The treatment of these fractures turns in a great measure upon the view that is taken of their mode of union, and on the constitutional condition of the patient. In some cases no union occurs, but the head of the bone remains in the acetabulum, being hollowed into a smooth, hard, cup-shaped cavity, in which the neck, which has become rounded off and polished, is received, and plays as in a socket.

The union of the intracapsular fracture of the neck of the femur takes place, however, in the great majority of cases by fibrous tissue. This is owing to two causes; in the first place, to the circumstance (which I look upon as the most important) that the fractured surfaces are not in apposition with one another; and secondly, that the vascular supply sent to the head of the bone, consisting only of the blood that finds its way through the vessels of the ligamentum teres, is insufficient for the proper production of callus.

In some cases, however, bony union takes place. This can only happen when, in consequence of the cervical ligament being untorn, or the fracture being impacted, the surfaces are kept in some degree of apposition, and the vascular supply to the head of the bone is speedily augmented by the blood carried into it through the medium of the plastic matter that is deposited between the fragments. In no other circumstance is it probable that osseous union takes place in these fractures: hence the infrequency of its occurrence, there being in all probability not more than eighteen or twenty cases on record as having thus terminated in this country. When bony union has taken place, the head will usually be found to be somewhat

twisted round in such a way that it looks towards the lesser trochanter, owing to the eversion that has taken place in the lower fragment.

Treatment.—As these fractures do not unite by bone, unless the fragments be in good contact, it is useless to confine the patient to bed for any long period, if the signs, especially the amount of *shortening*, indicate considerable separation between the fragments, or if the patient be very aged and feeble. In these circumstances, lengthened confinement to bed most commonly proves fatal by the depressing influence which it exercises on the general health, by the intercurrence of visceral disease, or by the supervention of bed-sores. It is therefore a good plan to keep the patient in bed merely for two or three weeks, until the limb has become somewhat less painful, the knee being well supported upon pillows. After this time, a leather splint should be fitted to the hip, and the patient be allowed to get up upon crutches. There will be lameness during the remainder of life; but, with the aid of a stick and properly adjusted splint, but little inconvenience will be suffered.

When the fragments do not appear to be much separated, there being but little shortening and indistinct crepitus, and more particularly if the patient be not very aged, and in other respects sound and well, an attempt may be made to procure osseous union. This may be done by the application of the long thigh-splint; or, if this cannot very readily be borne, by the double inclined plane, with a padded belt strapped round the hips. This apparatus should be kept applied for at least two or three months, when a leather splint may be put on and the patient move about upon crutches. During the whole of the treatment, a generous, and even stimulating diet should be ordered, and the patient kept on a water-bed or cushion. In these fractures of the neck of the femur, the starched bandage will often be found to be most useful. It may be applied as in fractured thigh, but should have additional strength in the spica part, and indeed may be provided with a small pasteboard cap so as to give more efficient support. In old people, this plan of treatment is especially advantageous, as it enables them to sit up or even to walk about, and thus prevents all the ill effects of long confinement in bed.

Extracapsular fracture of the neck of the thigh-bone is commonly met with at an earlier period of life than the injury which has just been described, being most frequent between the ages of thirty and forty. It is the result of the application of great and direct violence upon the hip, and occurs equally in both sexes.

This fracture may be of two kinds: the *simple*, or the *impacted*. In both cases the neck of the bone is commonly broken at, or immediately outside, the insertion of the capsule of the joint. The fracture is almost invariably comminuted; indeed, I have never seen a case in which the great trochanter was not either detached or splintered into several fragments. In many instances the lesser trochanter is detached, and the upper end of the shaft injured (Fig. 122). This splintering of the trochanter is owing to the same violence that breaks the bone, forcing the lower end of the neck into the cancellous structure of this process, and thus, by a wedge-like action, breaking it into fragments. When the neck continues locked in between these, we have the impacted form of fracture.

Fig. 122.

Extracapsular fracture of the neck of the thigh-bone: Detachment of the trochanter.

The *signs* of extracapsular fracture vary according as it is simple or impacted; but in both cases they partake of the general character of those that are met with in fractures within the capsule. The individual signs, however, differ considerably from these.

The hip will usually be found much *bruised and swollen* from extravasation of blood, which is often considerable. The *crepitus* is very distinct and loud, being readily felt on laying the hand upon the trochanter, and moving the limb. The separate fragments into which the trochanter is splintered may occasionally be felt to be loose. The *pain* is very severe, and greatly increased by any attempt at moving the joint, which to the patient is impossible.

The *eversion* is usually strongly marked, and the position of the limb is characteristic of complete want of power in it. *Inversion* occurs more frequently in this

fracture than in that within the capsule. Smith finds that of seven cases of inversion of the limb in fractures of the neck of the femur, five occurred in the extracapsular fracture; and of fifteen cases of intracapsular fracture, this condition was met with in three. When there is much comminution of the trochanter, the foot will commonly remain in any position in which it is placed, but generally has a tendency to rotate outwards.

The *shortening* of the limb is very considerable, being never less than from an inch and a quarter to two inches and a half, and often extending to three or four inches.

The *impacted extracapsular fracture* of the neck of the thigh-bone occurs when the upper fragment is driven into the cancellous structure of the lower one, remaining fixed there (Fig. 123). The signs of this form of fracture are often of a somewhat negative character, rendering its diagnosis and detection extremely difficult. There is pain about the hip, with slight eversion of the foot, and some shortening, usually amounting to about half an inch, but never exceeding one inch. There is but little crepitus—in some cases none can be detected; and the patient can then raise the foot for a few inches off the couch on which it is laid, and even walk upon it with a hobbling motion, though with much pain. In consequence of the impaction the limb cannot be restored by traction to its proper length, and hence incurable lameness always results from this injury.

Fig. 123.

Impacted extracapsular fracture of neck of thigh-bone.

The *diagnosis* of the different forms of fracture of the neck of the thigh-bone from one another, and from other injuries occurring in the vicinity of the hip-joint, is a matter of considerable importance, and often of no slight difficulty. Between the *intracapsular* and the ordinary *extracapsular fractures* there can be no difficulty; all the signs of the latter being so much more strongly marked than those of the former injury, the difference of age and the degree of violence required to break the bone being also important elements in the diagnosis, as may be seen by the annexed table.

Diagnosis between intra- and extra-capsular fractures of the neck of the thigh-bone.

Intracapsular.	*Extracapsular.*
1. Cause generally slight and indirect, such as catching the foot in the carpet or slipping off the curbstone.	1. Cause usually severe and direct violence, such as falling from a height or blow on hip.
2. Age, rarely below fifty; most commonly in feeble aged persons.	2. Age, usually below fifty; chiefly in vigorous adults.
3. Pain and constitutional disturbance slight.	3. Pain and constitutional disturbance usually considerable.
4. No apparent injury to soft parts about hip.	4. Considerable extravasation, ecchymosis, and signs of direct injury to hip.
5. Crepitus often obscure.	5. Crepitus (when not impacted) very readily felt.
6. Shortening usually at first not more than one inch.	6. Shortening (when not impacted) at least two inches or more.

It is more difficult to distinguish between the *intracapsular* fracture and the *impacted extracapsular fracture*. In the former case, however, the crepitus and eversion are more marked, and the injury usually occurs from less direct violence than when the fracture is outside the capsule. In the latter case, also, traction cannot restore the limb to its proper length as in the former instance.

In *severe contusions of the hip* there is sometimes eversion of the limb with inability to move it, so that at first sight it might be supposed that the bone was broken. In these cases, however, the absence of shortening and crepitus will always establish the diagnosis. The difficulty is greater, however, in those instances in which, the hip-joint having been the seat of *chronic rheumatic arthritis*, the limb is already somewhat shortened; here, however, the history of the case, and the fact of the shortening not being of recent occurrence, will be sufficient to establish the nature of the injury. The diagnosis of these injuries from *dislocations* will be considered in a subsequent chapter.

In the extracapsular fracture of the neck of the femur, death not uncommonly

results from the severity of the injury, the pain and irritation of the fracture, and the consequent shock to the system. The great extravasation of blood into the tissues of the limb has been known to be sufficient to account for the fatal result. When the patient lives, bony union takes place, large irregular stalactitic masses being commonly thrown out by the inferior fragment, so as to overlap the several splinters of bone. This callus is most abundant posteriorly in the intertrochanteric space (Fig. 124).

Fig. 124.

Impacted extracapsular fracture of neck of thigh-bone: Abundant formation of callus.

The *treatment* of the extracapsular fracture may very conveniently and efficiently be conducted by means of the long splint, a padded belt, if necessary, being strapped firmly round the hips underneath it; or the plan recommended by Sir A. Cooper, of placing the patient on a double inclined plane, with both feet and ankles tied together, and a broad belt, well padded, firmly strapped round the body, so as to press the fragments of the trochanter firmly against one another, will be found an excellent mode of keeping the limb of a proper length, and the fragments in contact.

Occasionally the fracture extends *through the trochanter major without implicating the neck of the bone.* Here there is shortening to about three-fourths of an inch, or an inch, with much eversion and crepitus readily felt. This fracture, which unites firmly and well by bone, must be treated in the same way as the last.

Compound fractures of the neck of the thigh-bone can only occur from bullet wounds. In these cases the choice lies between amputation at the hip-joint, resection of the injured portion of bone, or treating the case as an ordinary compound fracture. The choice of the surgeon, for reasons stated at p. 148, lies between the latter two alternatives, which are the only ones that afford a reasonable hope of safety to the patient.

2. *Fractures of the shaft of the thigh-bone* are of very common occurrence; every possible variety of the injury being met with here. They are usually oblique, except in children, when they are commonly transverse, and are often comminuted, double, or compound.

The *signs* are well marked. There is shortening usually to a considerable extent, with eversion of the limb, crepitus readily produced, and much swelling from the approximation of the attachments of the muscles. The lower fragment is always drawn to the inner side of the upper one, and rotated outwards; and when the fracture is high up there is a great tendency to angular deformity, in consequence of the projection forwards of the lower end of the upper fragment. In all cases there is this forward projection, and in most an outward displacement as well of this fragment. But in some instances, though more rarely, it is drawn inwards as well as forwards.

I have had three opportunities of ascertaining by dissection the condition of parts that leads to this eversion and projection forwards of the lower end of the upper fragment in fracture of the femur. The first case was that of an old man who died about three hours after meeting with a compound comminuted fracture of the middle and lower thirds of the right thigh-bone, and in whom this condition of the upper fragment was very distinctly marked. It was found that the gluteus maximus and medius could be divided without affecting the position of the bone; but when the gluteus maximus was cut across, it yielded somewhat. The pyriformis and external rotators were now felt to be excessively tense; and, on cutting these across, the end of the fragment could at once be drawn inwards, all opposition ceasing. The projection forwards still remained, however; and this, which was evidently due to the tension of the psoas and iliacus muscles, yielded at once on dividing them. It would thus appear that there must be a double displacement of the upper fragment; outwards, depending on the action of the external rotators; and forwards, owing to the contraction of the psoas and iliacus muscles.

The second case was one of displacement forwards and inwards. It was that of an elderly man, who died of internal injuries about half an hour after meeting with fracture of both thigh-bones at the junction of the upper and middle thirds by the passage of a cart-wheel across the thighs and body. In this case nearly the same

conditions were presented in both limbs. On the left side there was shortening to the extent of about two inches; the upper fragment was tilted upwards and rather inwards, the lower one being drawn up behind it to the extent indicated. On dividing the psoas and iliacus, the upper fragment could be depressed slightly. The adductor brevis and pectineus were now seen to be tense; on cutting them through, it could be still further depressed. It was now drawn strongly inwards owing to the extreme tension of the internal rotator muscles, more especially the obturator internus; on cutting them through, the fragment yielded completely. The lower fragment was broken off obliquely, and drawn upwards for two inches behind the upper one. The adductor magnus and part of the adductor longus were torn. The other muscles were uninjured. When extension was made with the limb straight out, the flexors of the leg offered a slight resistance: they were divided. The vastus externus was next cut through; the lower fragment could then be drawn down a quarter of an inch; on dividing the vastus internus and crureus, it yielded one inch more; on cutting through the adductor magnus and longus, it came down three quarters of an inch more; thus making up the two inches of shortening. On the left side, the fracture was the same as that in the other limb. The effect of the section of the different muscles was the same; but the vastus externus seemed to take a somewhat larger share in displacing the lower fragment.

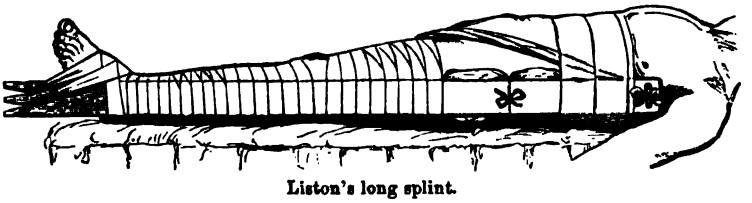
The *treatment* of fractures of the shaft of the thigh-bone may be conducted in six different ways, each of which presents advantages in particular forms of these injuries; hence an exclusive plan of treatment should not be followed.

Whatever treatment is adopted, and however carefully it may be carried out, the surgeon must not be disappointed if, in the adult, a certain amount of weakness be left. This is more particularly the case where the fracture is oblique and high up; the more transverse and the nearer the condyles, on the other hand, the less will be the liability to shortening. In children, union may almost always be procured without any shortening of the bone. A slight diminution in the length of the limb is in reality of no consequence, and gives rise to no inequality of gait; the pelvis, by the obliquity it assumes, remedying this. It is only when the shortening exceeds half or three-quarters of an inch, that it is important and occasions deformity.

1. The fracture may be treated by simply relaxing the muscles of the limb. This is effected by laying it upon its outer side, flexing the thigh well upon the abdomen and the leg upon the thigh, and supporting the limb in this position by an angular wooden or leather splint, extending from the hip to the knee or outer ankle, and by a short inside thigh-splint. This position I have occasionally adopted in fractures about a couple of inches below the trochanters, in which there is a great tendency to the projection outwards of the lower end of the upper fragment, and have found these cases turn out better in this way than by any other plan of treatment.

2. Extension, without regard to muscular relaxation, by means of Liston's long splint and perineal band (Fig. 125), will be found a most successful plan of treating fractures in the middle and lower parts of the thigh.

Fig. 125.



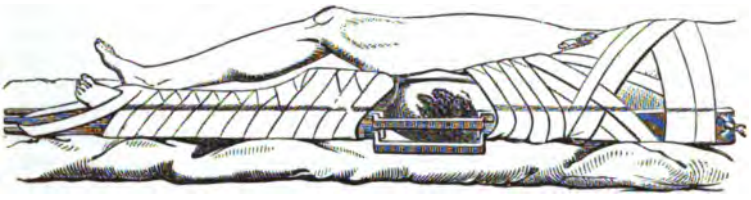
Liston's long splint.

In employing the long splint for the treatment of these fractures, care must be taken that it be of sufficient length to extend about six inches below the sole, and nearly as high as the axilla. The perineal band should consist of a soft handkerchief covered with oiled silk, and must be gradually tightened. If the perineal band occasion excoriation or undue pressure, so as to necessitate its removal, I have found advantage from keeping up extension with a heavy weight attached to the lower end of the splint.

In cases of compound fracture, where the aperture exists in the posterior and outer part of the limb, I have found a long thigh-splint, made of oak and bracketed

opposite the seat of injury, the most convenient apparatus, enabling the limb to be kept of a proper length, and the wound to be dressed at the same time (Fig. 126).

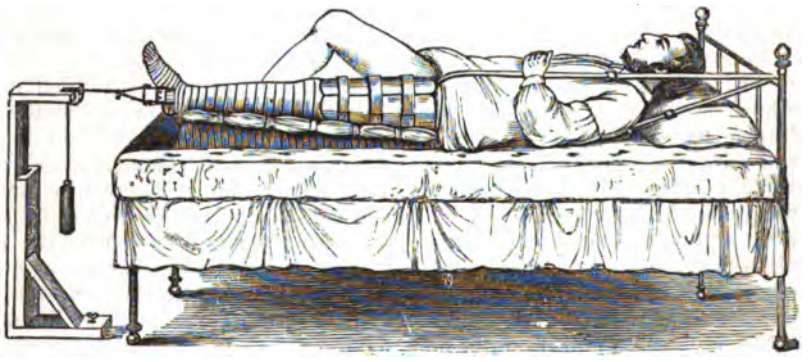
Fig. 126.



Compound fracture of shaft of thigh-bone: Treatment by bracketed long splint.

3. The double inclined plane is especially useful in many compound fractures of the thigh, often admitting of greater facilities for dressing the wound and the general management of the case, than any other apparatus that can be applied.

Fig. 127.



Fracture of shaft of thigh-bone: Treatment by weights and short splints.

4. Extension of the limb by the attachment of a weight to the foot, a plan of treatment employed by James, of Exeter, and perfected by Dr. Buck, of New York, is a most simple and efficient means of treatment. The accompanying drawing (Fig. 127) illustrates this well. The weight required for extension should vary in the adult from five to ten pounds. The counter-extending means consist of a perineal band, which should be of India rubber tubing properly covered and fastened to the head of the bedstead.

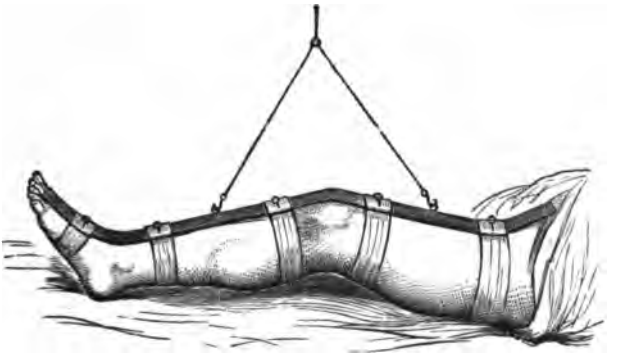
[The treatment by means of a weight, which is described by John Bell, and by him incorrectly attributed to Hildanus, is now deservedly in great favor in this country. Sufficient counter-extension may usually be obtained from the weight of the patient's body, by elevating the foot of the bed. For fractures of the shaft of the thigh-bone it will be found desirable to give lateral support and secure immobility of the hip and knee, by means of the long splint (I am in the habit of using the old Physick's splints and junct bags); while for fractures of the cervix femoris sufficient support may be given by the use of sand bags, applied to either side of the limb.—A.]

5. Suspension of the limb from a splint applied along its anterior aspect, as in Fig. 128, has been recommended by Dr. N. R. Smith, of Maryland. As a general plan of treatment, it is not likely to be found advantageous. But it is easy to understand that, in certain cases where injury was done to the soft parts of the limb posteriorly, it might be found very useful.

6. The starched bandage may be employed in most cases. In treating fractures of the shaft of the thigh-bone with the starched bandage, the following plan will be found convenient. The limb should be evenly and thickly enveloped in a layer of cotton wadding; a long piece of strong pasteboard, about four inches wide, soaked in starch, must next be applied to the posterior part of the limb, from the nates to the heel. If the patient be very muscular, and the thigh large, this must be strength-

ened, especially at its upper part, by having slips of bandage pasted upon it. Two narrow strips of pasteboard are now placed, one along each side of the limb, from

Fig. 128.



Limb suspended from splint by slings, preparatory to application of roller.

the hip to the ankle, and another shorter piece on the forepart of the thigh. A double layer of starched bandage should now be applied over the whole, with a strong and well-starched spica. It should be cut up and trimmed on the second or third day, and then reapplied in the usual way. With such an apparatus as this I have treated many fractured thighs, both in adults and children, without confinement to bed for more than three or four days, and without the slightest shortening or deformity being left (Fig. 101). The points to be especially attended to are, that the back pasteboard splint be very strong, at the upper part especially, and that the spica be well and firmly applied, so that the hip and the whole of the pelvis be immovably fixed.

A *simple comminuted* fracture of the thigh-bone is usually best treated in the double inclined plane for the first three weeks, after which it may be put up in the starch bandage.

The *treatment of compound and comminuted fracture of the thigh-bone* will vary according as the injury arises from gunshot injury, or is an accident of civil life. In the former case, for reasons stated at p. 148, amputation should at once be performed if the fracture be below the upper third of the bone. When the upper third is splintered, the result of amputation is so very unsatisfactory, that the patient may have a better prospect of recovery if the limb be treated in splints, and an endeavor made to save it, disarticulation at the hip-joint in such cases being almost invariably fatal.

When a compound, and even a comminuted fracture of the thigh-bone, occurs from one of the common accidents of civil life, the line of practice is not so defined. The course that the surgeon adopts must be influenced by the extent of injury done to the soft parts, more particularly to the main bloodvessels of the limb. If the integuments and muscles be extensively torn and lacerated, or if there be reason to believe that the femoral vessels have suffered, amputation must be practised. But if the wound be of but small size, made by the perforation of the bone rather than by the violence which occasioned the fracture, and if the vessels be uninjured, an attempt must be made to save the limb, which should be put up on the double incline or in the long bracketed splint.

The treatment of the complication of a *wound of the main artery*, femoral or popliteal, with and by a fracture of the thigh-bone, will vary according as the injury is compound or simple. Such an accident, complicating a compound fracture, is necessarily a case for immediate amputation. If the fracture be simple, and a diffused traumatic aneurism form in the ham or lower part of the thigh, we must, in accordance with the principles laid down at p. 242, ligature the superficial femoral artery; unless gangrene be supervening, or have actually supervened, when amputation of the thigh must be practised above the line of fracture.

In discussing the treatment of these accidents, in which the question of amputation of the thigh is raised, I cannot too strongly state my conviction that, unavoidable as it undoubtedly is in some cases, as the only alternative left to the surgeon,

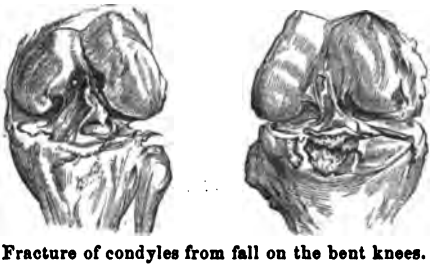
this operation, when practised primarily *for injuries of the thigh-bone itself*, is one of the most fatal in surgery, and should accordingly not be too hastily resolved upon.

3. *Fractures in the vicinity of the knee-joint.*—The lower end of the thigh-bone may be broken across in a transverse direction, through the line of junction between the epiphyses and the shaft, both condyles being detached. This most readily occurs in children, from the lower epiphyses not being as yet solidly united to the shaft of the bone. In other cases, the fracture extends through one of the condyles, detaching it from the shaft of the bone. The readiness with which crepitus can be felt, the line of fracture made out, and the displacement removed by lateral pressure, determines at once the nature of this accident. These cases are best treated on the double inclined plane. I have had several cases of *impacted fracture* in this situation under my care. In one, the upper fragment, which was very oblique, was firmly driven into the cancellous structure of the lower one (Fig. 129). In another case, the condyles of both thigh-bones were splintered into a number of fragments, amongst which the shafts were impacted. Excellent union, however, took place, the skin having been uninjured. In the case from which Figs. 130 and 131 were taken, the patient fell

Fig. 129.

Impacted fracture of lower end of thigh-bone.

Fig. 130. Fig. 131.



Fracture of condyles from fall on the bent knees.

from a great height on the bent knees and splintered the condyles upwards from their articular surfaces. The head of the tibia, especially in the right knee, was also fractured. Fracture of the lower end of the thigh-bone, communicating with open wound of the knee-joint, is necessarily a case for amputation.

Fractures of the Patella may be the result of direct violence, when the bone is often comminuted, or even broken longitudinally, being split, and the joint possibly injured. But most frequently they occur as the consequence of muscular action; the bone being torn across by the violent effort made by the extensor muscles of the thigh, in the attempt a person makes to save himself from falling when he suddenly slips backwards. All fractures of the patella from muscular action are transverse; the lower portion of the bone being fixed by the ligamentum patellæ, the upper segment is torn off by the spasmodic action of the extensors at the moment when the knee is bent, whilst the person is in the act of falling backwards. The patient does not break his patella in these cases by falling upon it, but he falls because the patella has been torn asunder by the violent and almost spasmodic action of the extensors of the thigh in his efforts to save himself. In consequence of these fractures being occasioned by muscular action, they are more frequent in men, especially about the middle period of life, less common in women, and extremely rare in children. I have once, however, had under my care a child under ten years of age, who had a transverse fracture of the patella. It not unfrequently happens when one patella has been fractured, that the unsteadiness of gait causes the opposite one to be broken by muscular action in an effort to save a fall. The same patella may be broken more than once; in the cases that I have seen, the second fracture has always occurred in the upper fragment, a little above the line of the original fracture.

The *signs* of this fracture are very evident. When it is transverse, the separation between the fragments (Fig. 132), which is much increased by bending the knee (Fig. 133), and the inability to stand or to raise the injured limb, indicate what has

Fig. 132.

Fractured patella: side view of limb, straight.

happened; when it is longitudinal or comminuted, the crepitus and mobility of the fragments point it out; and there is usually considerable swelling of the knee-joint in these cases, with, perhaps, wound of it.

Mode of Union.—When the bone is broken transversely, it very rarely indeed unites by osseous matter, in consequence of the wide separation of the fragments; there are, however, two or three cases on record in which this kind of union has taken place in these fractures. In the longitudinal and comminuted fractures, osseous union readily occurs, the fragments remaining in close apposition. In the majority of cases of transverse fracture, the fragments remain separated by an interval varying from one-fourth of an inch to an inch; but in some instances the gap is much greater, amounting even to four or five inches. When the separation does not exceed an inch and a half, the gap is usually filled up by fibrous or ligamentous tissue, uniting the fragments firmly. In some of the cases, however, in which the separation between the fragments does not exceed this distance, and in most of those in which it extends beyond it, Mr. W. Adams has found that the fracture is not united by any plastic matter that has been thrown out, but that the fragments are bound together simply by the thickened fascia which passes over the patella, with which is incorporated the bursa patellæ. Mr. Adams finds that the aponeurotic structure thus uniting the fragments may be arranged in different ways. Thus it may pass between, and be adherent to the anterior periosteal surface of both fragments; or the connecting aponeurosis may be reflected over, and be adherent to, both the fractured surfaces; or lastly (and this is the most frequent form of arrangement), the connecting aponeurosis may pass from the periosteal surface of the upper fragment to the fractured surface of the lower one, to which it becomes closely and firmly united. In the majority of cases, when united by aponeurotic tissue, the fragments gape somewhat towards the skin, coming into better contact posteriorly. Thus, it would appear that a patella fractured transversely may unite in two ways; most frequently by the intervention of thickened aponeurotic structure, and next, by a ligamentous or fibrous band. Of 31 specimens in the London museums, examined by Mr. Adams, it was found that in 15 aponeurotic union had taken place, in 12 ligamentous union, and in the remaining 4 the kind of union could not be determined.

Fig. 133.

Fracture of patella; separation between fragments increased by bending the knee.

The aponeurotic union always leaves a weakened limb and an unprotected joint; for, in consequence of the separation of the fragments, the folding in of the fascia, and its adhesion to the capsule of the joint, the fingers can be thrust in between the articular surfaces of the knee.

Treatment.—In many cases of fractured patella, there is rather severe inflammatory action in the knee, with great synovial effusion. This requires to be reduced by rest and the application of evaporating lotions, before any other treatment can be adopted. When this has been effected, means must be taken for the union of the fragments; with this view, the principal point to be attended to is, to keep the fragments in sufficiently close apposition for firm ligamentous union to take place between them. With this view, the upper fragment, which is movable, and has been retracted by the extensor muscles of the thigh, must be drawn down so as to be approximated to the lower one, which is fixed by the ligamentum patellæ. This approximation of the fragments may be effected either by position and relaxation of the muscles, or by mechanical contrivance. Simple position usually suffices for this purpose, and must be attended to whatever mechanical appliances are used. By placing the patient in a semi-recumbent position, and elevating the leg considerably, so as to relax the muscles of the thigh completely, the upper fragment may be brought down to the lower one, and, if necessary, may be retained there, after any local inflammation that results from the accident has been subdued, by moulding a gutta-percha cap accurately to and fixing it firmly upon the knee, or by the applica-

tion of pads of lint and broad straps of plaster. These straps of plaster may be applied above and upon the upper fragment in a diagonal direction from above downwards. They should be of sufficient length to embrace the limb and the back splint, to which they are to be fixed, or a figure-of-8 bandage may be applied round the limb and splint together. This position must be maintained for at least six weeks; at the expiration of which time the patient may be allowed to walk about, wearing, however, an elastic knee-cap, or, what is better, a straight leather splint in the ham, so as to prevent the knee from being bent for at least three months. If this precaution be not taken, the union between the fragments, which at first appear to be in very close contact, will gradually lengthen, until in the course of a few months an interval of several inches may be found between them. In these cases, however, even though the separation between the fragments be great, it is remarkable how well the limb may be used, especially on level ground; and with the aid of a knee-cap but little inconvenience is experienced by the patient.

In most cases of fractured patella the starched bandage will be found a very useful mode of treatment, the patient being with it enabled to walk about during the whole of the treatment. The action of the bandage is much increased by drawing down and fixing the upper fragment by two broad strips of plaster firmly applied above it. A back splint of pasteboard is required to fix the knee, and a good pad of lint with a figure-of-8 bandage should be applied above and below the fracture to keep it in position. In several cases I have obtained very close and firm union between the fragments in this way, without confining the patient to bed after the third day, and now seldom employ any other method of treatment.

Various attempts have at different times been made to bring down and to fix the upper fragment, so as to keep it in contact with the lower one; or, if this be impracticable, to shorten the distance between them, and thus to lessen the length of the bond of union. With this view, an apparatus consisting of two broad bands of leather, buckled above and below the knee, and united by longitudinal straps, which can be shortened at pleasure, is very commonly employed. Malgaigne, with the same view, constructed a pair of double hooks, which being fixed into the two fragments, were drawn together by a screw; and Eve, of Tennessee, accomplishes the same object by means of a ring passed round the fragments. All these means undoubtedly secure the object for which they are intended, and each may be found an useful adjunct to position in any given case. Malgaigne's hooks are undoubtedly the most effectual; but the great objection to their use consists in the pain and irritation that are often induced by their penetration of the skin.

In *simple comminuted fractures of the patella*, the result of direct blows or kicks, the fragments are not much separated, and union takes place readily by bone. In these cases, after subduing inflammatory action, which usually runs high, the starched bandage may be applied, and the knee and fragments thus both kept immovable.

Compound and comminuted fractures of the patella, especially if occasioned by bullet-wounds, and opening the knee-joint, are cases for immediate amputation.

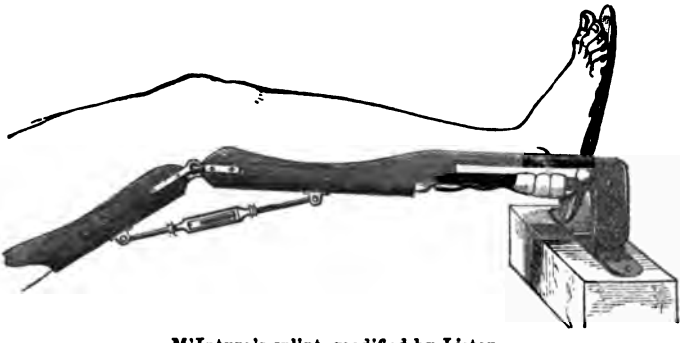
Necrosis of the patella as the result of fracture is of rare occurrence. In one such case which was under my care at the hospital, the patient, a middle-aged man, had met with an ordinary transverse fracture of the patella, which united by ligament two years after the accident; and without any fresh injury he came to the hospital, with necrosis of the outer half of the upper fragment, which was completely detached and lying in a cavity bounded and shut off from the joint by plastic matter. I cut down upon and removed the necrosed fragment, which appeared to constitute about one quarter of the patella. No cause could be assigned for the necrosis, except defective vascular supply to this part of the bone.

Fractures of the Bones of the Leg.—The bones of the leg are frequently broken. The tibia, though a stronger bone than the fibula, is most frequently fractured, owing to its being more exposed and less protected by muscles, and receiving more directly all shocks communicated to the heel. The fractures of the upper part of this bone are usually transverse, and result from direct violence; those of the lower part are oblique, and proceed from indirect violence. When both bones are broken, the usual signs of fracture, such as shortening, increased mobility at the seat of injury, and crepitus, render the diagnosis easy; but when one bone alone is broken, it is not always a very simple matter to determine the existence of the fracture; the sound bone, acting as a splint, prevents displacement, and keeps the limb of a proper length and steady. If it be the tibia alone that has been

broken, the fracture may be detected by running the finger along the subcutaneous edge, until it comes to a point that is somewhat irregular, puffy, or tender, where by accurate examination some mobility and slight crepitus may be detected. When the fibula alone is broken, the thick layer of the peroneal muscles, overlaying its upper two-thirds, renders the detection of the fracture difficult; but in the lower third it is easy, by attention to the same signs that occur in fractured tibia.

In the *treatment* of fractures of the leg, M'Intyre's splint (Fig. 134) will usually be found of great service in the earlier periods, more especially if there be much

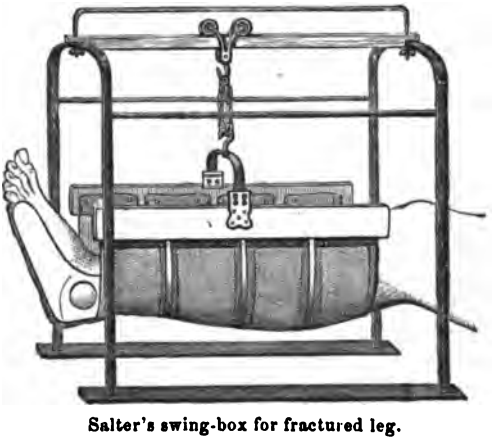
Fig. 134.



M'Intyre's splint, modified by Liston.

ecchymosis or extravasation, as it keeps the limb in an easy position, and allows the ready application of evaporating lotions. After the swelling has subsided, the starched bandage should be applied, and the patient be allowed to move about on crutches. In some cases of fracture of the bones of the leg, however, M'Intyre's apparatus is not applicable. This is more particularly the case when the fracture is very oblique, from above downwards, and from before backwards; in these circumstances, the fragments cannot be brought into good position so long as the limb is kept extended and resting on its posterior surface; the bones riding considerably, and one or other of the fractured ends pressing upon the skin in such a way as often to threaten ulceration. In these cases it is, that division of the tendo Achillis has been recommended, with a view of removing the influence of muscular contraction. This appears to me, however, to be an unnecessarily severe procedure, and certainly was not a very successful one in two cases in which I practised it; for although the tendon was exceedingly tense, but temporary benefit resulted, the displacement returning under the influence of the other muscles inserted into the foot. In these cases the bones may usually be brought into excellent position by flexing the thigh well upon the abdomen, and the leg upon the thigh, so that the heel nearly touches the nates, and then laying the limb on its outer side on a wooden leg-splint, provided with a proper foot-piece, and keeping it fixed in this position. In some cases the swing-box (Fig. 135) will be found a useful and very easy apparatus. In some fractures of the leg, the lower end of the upper fragment projects considerably, and cannot be got into proper position so long as the knee is kept bent; but if it be extended, so as to relax the extensors of the thigh, the bone is readily brought into good position. In fractures of the leg, however, as in all injuries of a similar kind, no one plan of treatment should be adopted exclusively, but the means employed should be varied and suited according to the peculiarities of each individual case

Fig. 135.

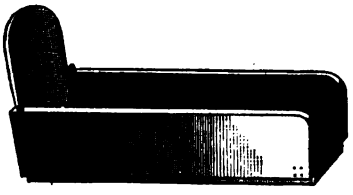


Salter's swing-box for fractured leg.

In the management of all fractures of the leg, it is of importance that the position of the foot be carefully attended to. It should be kept as nearly as possible at right angles to the leg. If it be allowed to drop, so that the toes point, there will be a tendency for the astragalus to slip forwards from under the malleolar arch; the ankle-joint being thus permanently weakened by the elongation of its anterior ligament.

[Fractures of either bone, or of both bones of the leg, are usually treated in this city with the ordinary fracture box, with movable sides, the limb being supported in it by means of a soft pillow. Very oblique fractures are sometimes best treated with the anterior splint of Prof. N. R. Smith, of Baltimore. In cases of very young children, or of adults suffering from mania-à-potu, where no restraint can be borne, I have found it best to bandage the broken limb securely in a soft pillow; the patient can then toss it about without risk of injury.—A.]

Fig. 136.



Fracture box, with movable sides.

For the treatment of *complications of simple fracture of the leg*, see pp. 238, *et seq.*

Compound fractures of the tibia are of more frequent occurrence than similar injuries of any other bone in the body. This is owing to the thin covering of soft parts over the anterior and inner aspect of the bone, and to the fact of these fractures being usually oblique; so that the sharply pointed end of the upper fragment is liable to be thrust through the integument, when the lower part of the limb falls backwards as the injured person is being raised off the ground. The fracture may, of course, also be rendered compound by the same direct violence that breaks the bone.

The *treatment* and probable result of the case will in a great measure depend upon the way in which the fracture has been rendered compound, and on the amount of the laceration and contusion of the integuments. When the wound in the integuments is the result of their transfixion by the point of the upper fragment, it may commonly be closed by the first intention, by laying over it a piece of lint soaked in blood or in collodion, or using Lister's carbolic acid dressing, composed of one part of the acid to five of whitening, or to ten of linseed oil, after reduction has been effected, and the limb put on a M'Intyre's splint, the lint being left undisturbed as long as possible. Should there be difficulty in preventing the protrusion or in effecting the reduction of the pointed fragment, this must be cleanly sawed off, or the wound be enlarged so as to sink it, as directed at p. 243.

In the event of there being great contusion and laceration of the soft parts, as when the fracture is rendered compound by a wagon wheel passing over the leg, it is useless to adopt the routine practice of attempting to close the wound by laying over it a piece of lint soaked in blood or collodion. It cannot unite, as in the other case, by the first intention. Suppuration must take place, and this is best met at once by the application of water-dressing after reduction. Indeed, in cases of this kind, the greatest danger results to the patient from the surgeon plastering the wound over with a piece of lint rendered hard and impervious by dried blood. The inflammatory discharges are prevented from escaping; and unhealthy pus or broken down blood accumulates in the limb, which becomes greatly swollen, tense, red, painful, and hot. The patient becomes restless; high irritative fever is set up; and, unless relief be given by the evacuation of the pent-up discharges, by opening up the wounds freely, and perhaps by free incisions and counter-openings as well, the worst forms of pyæmia will almost inevitably ensue.

[For compound fractures of the leg there is no better application than the bran dressing recommended by Dr. J. Rhea Barton. The limb is placed in the ordinary fracture-box and surrounded with clean bran. Hemorrhage is checked, all discharges quickly absorbed, and the soiled bran can be easily removed and its place supplied without disturbance of the limb.—A.]

If the tibia be much comminuted and the fracture compound, the case is usually one for amputation; but should the patient be young and vigorous, an attempt even in such cases may be made to save the limb. Here a good deal may be done in the way of picking out detached splinters of bone, and sawing off smoothly the jagged and pointed ends of the adherent fragments. The length of the tibia will

thus be lessened, and the patient will recover with a necessarily shortened, but otherwise firm and useful limb. Care must be taken in the after-treatment of such cases that too effective extension be not kept up, lest a gap be left between the fractured ends, which cannot be filled up with callus; the consequence being that, in the attempt to obtain good length of limb, want or imperfection of consolidation results.

In both the last classes of cases, tension of the limb from deep abscess, possibly requiring incision, may ensue; or the consolidation of the fracture and the healing of the wound may be retarded by necrosis of some of the splinters, or of the extremity of one of the fragments, generally the lower one; and not unfrequently, after a proper but unsuccessful attempt to save the limb, the profuseness of the suppuration and the amount of constitutional debility may render imperative secondary amputation above, at, or below the knee. This in civil practice has been attended, in both the leg and the thigh, with more satisfactory results than have followed the primary operation. For the consideration of the question of secondary amputation, see p. 62.

Hemorrhage is a common complication of compound fractures of the leg. When venous and moderate in quantity, it may be arrested by position and cold. When arterial and abundant, proceeding from laceration of one of the tibials, the line of practice to be adopted must to a great extent be determined by the situation of the fracture, and of the concomitant arterial wound. If these be anywhere above the lower third of the limb, it is useless for the surgeon to attempt to secure the bleeding vessels by groping amongst and under the deep muscles of the limb, infiltrated and disorganized as they are by the injury and by extravasation. It is equally futile, in these cases, to ligature the superficial femoral artery. Such an operation either fails in arresting the hemorrhage, or, if it stop the circulation sufficiently for this, gives rise to gangrene. There is, consequently, no resource but amputation; and the sooner this is practised the better will be the patient's chance of recovery. If, however, the fracture be situated and the artery be torn low down in the limb, where the vessels are superficial, and more especially if the injury be near the ankle-joint, an attempt might be made—provided other circumstances were favorable—to apply a ligature to the bleeding artery, and thus to save the limb. This would be more feasible if the anterior than if the posterior tibial were the artery wounded.

In fractures of the leg, the starched bandage is especially applicable. It should be applied as follows: The limb having been well covered with wadding, a strong soaked pasteboard splint, four inches broad, and long enough to extend from above the knee to six or eight inches beyond the heel, should be applied to the back of the leg. The projecting terminal piece is now to be turned up along the sole of the foot, and two lateral strips adapted to either side of the limb. Over this the starched bandage, single or double according to the size of the limb, must be tightly applied. After it is dry, about the end of the second day, it must be cut up as represented in Fig. 103, and readjusted, and the patient may then walk on crutches with perfect safety. In compound fractures of the leg, a trap may be cut in the bandage, as represented in Fig. 104, through which the wound can be dressed.

Fractures in the vicinity of the ankle-joint are amongst the most common injuries of the bones of the lower extremity. They are usually occasioned by twists of the foot, by catching it in a hole whilst running, by jumping from a height to the ground, or off a carriage in rapid motion. These fractures are usually associated with severe strain, or even dislocation, of the ankle. Twist of the foot in these cases must not be confounded with dislocation of the ankle. In a twist the foot carries with it the lower fragments of the leg-bones, and the malleolar arch in a more or less perfect state. In a dislocation, the foot is thrown out from under this arch. The twist of the foot is almost invariably outwards, with the inner side downwards and the outer edge turned up, or the sole remaining in this direction, though not always to the extent that Dupuytren states, and the inner malleolus projecting under the skin. Most commonly the toes are turned somewhat out, and the heel in.

Fractures of the lower ends of the tibia and fibula present four distinct varieties in degree.

1. The fibula may be broken two or three inches above the malleolus externus, the deltoid ligament being either stretched or torn.

2. The fibula may be fractured about three inches above the ankle, the tip of the

malleolus internus being splintered off as well. This constitutes the form of injury called *Pott's fracture*, and is perhaps the most common fracture in this situation.

Fig. 137.

Fractures of tibia and fibula above ankle.

3. The fibula may be fractured about three inches above the ankle, and the lower end of the tibia at the same time be splintered off in an oblique direction from without, downwards and inwards (Fig. 137).

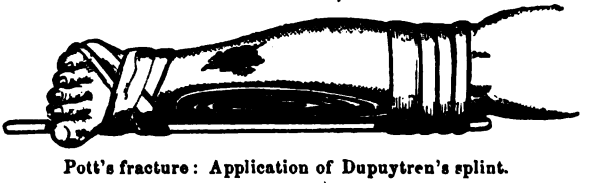
4. The internal malleolus may alone be broken off, the fibula remaining sound, but one of the divisions of the external lateral ligament being torn through.

The *signs* of these fractures vary somewhat according to the bone that is injured. When the fibula alone is broken, there is but slight displacement of the foot, but great pain and much swelling, with perhaps indistinct crepitus, and irregularity of outline at the seat of fracture. If the tip of the inner malleolus be broken off as well, this may be ascertained by feeling the depression above the detached fragment. In those cases the crepitus is more distinct, and the displacement of the foot is much more marked, the sole being turned somewhat upwards and outwards, and the patient resting upon its inner side. It is this peculiar twist of the foot with its outer edge turned up, and the inner side down, that constitutes the characteristic sign of Pott's fracture. In those cases in which the lower end of the tibia is obliquely splintered, as well as the fibula broken, there are not only the ordinary signs of fracture, with eversion of the toes, and a corresponding turning inwards of the heel, and some rotation of the foot outwards, but the malleoli are widely separated, giving an appearance of great increase of breadth to the joint; crepitus is very readily felt, and a depression can be perceived corresponding to the line of fracture.

The *treatment* of these cases is always fraught with difficulty. In consequence of the swelling and inflammation that usually occur, it is often difficult to exercise that amount of traction and pressure necessary for the proper coaptation of the fragments. This difficulty is greatly increased by the small size and short leverage afforded by the fragments; and so great is it, that in some cases it cannot be overcome, but a certain degree of displacement results as the necessary consequence of the injury, leaving a weak and painful joint, the mobility of which is seriously impaired.

If, as usually happens, more particularly when the fracture results from direct violence, there be a good deal of swelling from ecchymosis and inflammatory action, this will require to be subdued by the continuous application of cold, and the limb should be laid on a splint. If there be not much displacement of the foot, the treatment may best be conducted by splints with good foot-pieces, and the starched bandage. When there is no twist of the foot, perhaps the best apparatus is a M'Intyre's splint; or the limb may be put up in lateral leg-splints, with good foot-pieces, and swung in a cradle. Whatever apparatus is used, care must be taken to keep the sole of the foot nearly at a right angle with the leg. If the toes be allowed to point, it will be found that there is in some cases a tendency for the astragalus to roll forwards, as it were, from under the malleolar arch. In other instances, again, one of the sharp angular fragments connected with the bone, may be pressed forwards, and uniting in this position, give rise to permanent deformity. But whatever care be employed, or apparatus applied, it will be found impossible in some cases to replace one of the thin angular fragments, if it become twisted on its axis,

Fig. 138.



Pott's fracture: Application of Dupuytren's splint.

and project sharply under the skin. If the foot be much twisted outwards, as often happens in Pott's fracture, Dupuytren's splint should be applied to the inner side

of the limb, so as to counteract the displacement. The pad should be folded double at the lower end, and not descend below the ankle, so as to form a fulcrum, across which the foot may be drawn to the inner side (Fig. 138). Much stiffness is always left after union has taken place, the ankle remaining rigid, weak, and useless for a long time.

[These fractures may be safely treated in the ordinary fracture box, the deformity being obviated by the use of suitable compresses.—A.]

Compound fracture into the ankle-joint, though necessarily a serious and dangerous accident, may often be recovered from with a good and useful limb, more particularly when occurring to young subjects of sound constitution. In such individuals, even though the injury be very extensive and severe, recovery may take place; but as age advances, and the constitution becomes more broken, less is to be expected from conservative surgery.

In the *treatment*, the course to be pursued will depend upon the extent of the injury. If the fracture be not much comminuted, the wound in the soft parts clean cut and but moderate in extent, and the large vessels of the foot uninjured, an attempt should be made to save the limb. If, on the other hand, there be great comminution of bone, with dislocation of the foot, and perhaps, rupture of the posterior tibial artery, in a person at or above the middle period of life, amputation should be practised. But in a younger subject, such a serious injury even as this may be recovered from, if the surgeon remove loose fragments, saw off the splintered ends of the bone, and bring the soft parts together.

If an attempt be made to save the limb, whether any bone have been excised or not, it should be placed securely in a M'Intyre's splint (Fig. 134) and kept immovably fixed; perfect fixity of the limb is here of the first consequence. If much of the fibula should require removal, Stromeyer has recommended that the limb be amputated instead, lest an useless foot, affected with a kind of valgus, be left. But, in children and young subjects, this inconvenience and deformity may be overcome by mechanical means; and the probability of its occurrence would not, in my opinion, justify amputation.

Fractures of the Bones of the Foot almost invariably result from direct violence, and are usually accompanied by much bruising and injury of the soft parts; hence there is usually but little displacement, and, when the fracture is simple, rest and position alone are necessary. Compound fractures of the tarsal or metatarsal bones, attended by much bruising and laceration of the soft tissues, usually require partial removal of the foot, its disarticulation at the ankle-joint, or amputation in the lower third of the leg, according to the extent and severity of the injury.

The only special fractures of the foot requiring particular attention, are those of the calcaneum and astragalus.

The *calcaneum* may be broken by direct violence, as when a person jumping from a height alights forcibly on his heel, and thus fractures the bone. In this way the bone is usually simply broken across in front of the ligaments, without displacement. I have, however, seen both calcanea extensively comminuted, being shattered to pieces, in the case of a lady, who, falling from a window on the third story, alighted on her heels. More commonly, however, the bone is simply broken across. In some rare cases, by the powerful contraction of the strong muscles of the calf, the posterior part of the os calcis is torn away from the rest of the bone.

Signs.—When the os calcis is simply broken through at its posterior part beyond the insertion of the lateral ligaments, the detached fragment will be drawn up by the action of the strong muscles of the calf. But when the fracture occurs across the body of the bone, no displacement can take place, owing to the lateral and interosseous ligaments keeping the posterior fragments in position, and preventing its being drawn away.

In the first form of fracture, the pain, swelling, flattening of the heel, and prominence of the malleoli, indicate the nature of the injury, even though crepitus be wanting In the second variety, the mobility of the fragment, and its projection posteriorly by the action of the muscles of the calf, point to the existence of the fracture, which is confirmed by the occurrence of crepitus.

In the *treatment* of these injuries, subduing inflammatory action, keeping the part fixed, by means of bandages and gutta-percha splints, with due attention to the relaxation of the muscles, is all that can be done. Union probably occurs

[Fig. 139.

Apparatus for rupture of tendo Achillis, or for fractured calcaneum.]

by bone in some cases, though very commonly by fibrous tissue.

[In cases where there is much displacement, the apparatus (Fig. 139) recommended for ruptures of the tendo Achillis may be usefully applied.—A.]

The *astragalus* alone is rarely broken. Ten recorded cases of this injury have been collected by Monahan: in nine of these the fracture occurred from falls from a height on the foot; in one only from direct violence. I have seen two cases of fracture of this bone only without implication of any other of the tarsal bones. In one case it was the result of direct violence; a cart-wheel passing over the foot occasioned a fracture of the astragalus through its neck. There was no material displacement, but the line of fracture could be readily felt, and crepitus was very distinctly elicited on flexing and extending the foot. No better treatment can be adopted in such a case than the starched bandage.

In the other case the fracture was the result of indirect violence, the patient, a man about thirty years of age, falling from a height of about eight yards, and alighting on his feet. In this case the fracture was evidently occasioned by the foot being forcibly driven up into the malleolar arch, so that the astragalus was broken across transversely just in front of the surface that articulates with the tibia—the line of fracture running obliquely downwards and backwards, so that the whole of the upper and posterior part of the bone was detached. This large fragment was widely displaced, being drawn outwards and backwards, so as to lie between the fibula and the tendo Achillis, lacerating the skin to the extent of about one inch longitudinally, and projecting through the opening thus made. The foot presented a singular degree of deformity, which is represented in the annexed figure (Fig. 140). The outer malleolus projected greatly; and immediately behind this the displaced fragment could be felt and seen partially protruding through the rent in the skin. The inner malleolus was depressed; there was a deep hollow below this. The os calcis was apparently turned somewhat towards the inner side of the foot. The sole was arched, the skin much wrinkled, and the great toe forcibly flexed. There was a deep transverse furrow in front of the ankle-joint. On discovering the nature of the accident, and seeing the hopelessness of reduction, or rather the impossibility of maintaining the displaced fragment in position, I cut down upon it by enlarging the opening through which it showed itself, and then, seizing it with strong bone-forceps, twisted it out, dividing the ligamentous connections. The case was then treated as one of compound dislocation of the ankle-joint. About a month after the accident the patient died of pyæmia; and, on examining the foot, it was found that the anterior portion of the astragalus had been splintered into seven fragments, which were retained in place by the pressure of the surrounding parts. No other bone of the tarsus was injured, nor was the malleolar arch fractured. Of this splintering of the anterior fragment, there was no evidence during life; nor was there any reason to suspect it, as there was neither crepitus nor displacement. The extent of the fracture showed the immense force with which the astragalus had been driven into and against the malleolar arch. Were such a case again to occur to me, I should certainly amputate at once.

Fig. 140.

Comminuted fracture of astragalus: Displacement backwards.

The only similar case with which I am acquainted is one recorded by Norris (U. S.). In this, the displaced fragment did not occasion a wound of the integu-

ment. It was excised owing to the impossibility of reducing it; but the anterior part of the astragalus which was left fell into a state of caries, which spread to the other tarsal bones, rendering amputation of the foot eventually necessary.

In all cases of fracture of the tarsal bones, whether simple or compound, with so much displacement as to render reduction difficult and its maintenance impossible, the best course to be pursued is doubtless that taken in the above cases—of cutting down upon and removing the displaced fragment. I know not what else can be done.

[In a case which was under my care at the Pennsylvania Hospital, the displacement was precisely the same as in that described by Mr. Erichsen, viz., downwards, outwards, and backwards: in my case the fracture was simple, and reduction was easily accomplished, the patient making a good recovery. (*American Journ. Med. Sciences*, April, 1862, pp. 335–340.) In Dr. Norris' case the displacement was forwards.—A.]

Fracture of the metatarsal bones usually occurs from direct violence, as by the passage of a cart-wheel over the limb, and is then attended with so much laceration and bruising of the soft parts as not unfrequently to render amputation necessary. I have in one instance known the three outer metatarsal bones broken by a person jumping from a height. But most commonly their elasticity saves them, and the ankle-joint gives way in such an accident. There is but little, if any, displacement in these cases; and unless the soft parts be so damaged as to require amputation, the support of a starched bandage is usually all the treatment that is necessary.

CHAPTER XX.

DISLOCATIONS.

By a *dislocation* is meant the more or less complete displacement of the bony structures of a joint. In the orbicular joints, as the hip and shoulder, the osseous structures may be completely separated from one another, the dislocation then being *complete*. In the hinge-joints, as the elbow and knee, the osseous surfaces commonly remain partially in contact, though displaced from their normal relations to one another; here the dislocation is *incomplete*. In most dislocations the integuments covering the displaced bones are put greatly on the stretch; but in some they are ruptured, and then the dislocation is *compound*. Besides these varieties, surgeons recognize *spontaneous* dislocation, in which the displacement does not occur from external violence. In other cases again, the dislocation arises from *congenital* malformation of the joint in consequence of which the bones cannot remain in proper apposition.

Causes.—Dislocation is *predisposed* to by various conditions, amongst which the arrangement of the joint appears to exercise most influence; orbicular joints being more liable to dislocation than any of the other articulations, whilst in some of the synchondroses it never occurs. Malgaigne finds that, of 491 cases of dislocation, 321 occurred in the shoulder, 34 in the hip, 33 in the clavicle, 26 in the elbow, 20 in the foot, besides others in the thumb, wrist, and jaw.

Dislocations are seldom met with in children, in whom fractures through the line of junction between the epiphysis and shaft more readily occur. I have, however, had under my care a child, just one year old, with dislocation of the head of the femur on the os pubis, occasioned by another older child dragging it along the ground by its leg; Kirby and Madge have both seen dislocations of the femur on to the dorsum ilii in children of three and three and a half years old; and Travers has seen the hip dislocated in a boy five years of age. In old people the bones are so brittle, and the ligaments so tough, that violence causes fracture rather than dislocation. Hence it is principally in young and middle-aged subjects that dislocations are met with. This is well illustrated by an analysis of 84 cases of dislocation of the hip-joint, collected by Hamilton; of these, 15 occurred under 15 years of age, 32 between 15 and 30, 29 between 30 and 45, and 8 between 45 and 85. They are

necessarily far more common in men than in women, from the nature of their respective occupations. Thus, according to Hamilton, of 115 dislocations of the hip, only 11 occurred in women.

It is well known that it is rather owing to the continuous tension of the muscles, than to any arrangement of osseous and ligamentous structures, that the articular ends of the bones of the extremities are kept in their proper positions, and that considerable external violence may be applied to a limb without dislocating it. If, however, the muscles be taken by surprise, or if they have been weakened by previous injury of any kind, the joint becomes predisposed to dislocation, and may be displaced under the influence of very slight causes. In this way the same joint may be repeatedly dislocated. Thus I have seen a man whose humerus had been dislocated between forty and fifty times, owing to a weakened state of the deltoid.

The *direct causes* of dislocation are *external violence* and *muscular action*. *External violence* may act directly upon a joint, forcing or twisting the articular ends asunder, as happens when the foot is displaced by a twist of the ankle, or when the thumb is dislocated backwards by a blow. But more commonly the force acts at a distance from the joint that is displaced, and the head of the bone is thrown out of its socket by "the lever-like movement of the shaft," as happens when the head of the humerus is dislocated by a fall on the hand.

Muscular action alone may cause the dislocation of a bone, even though the part be previously in a sound state. Thus, the lower jaw has been dislocated by excessive gaping, and the humerus by making a violent muscular effort. If the joint have already been weakened by previous injury or disease, muscular action is especially apt to occasion its displacement. Congenital dislocations, in all probability, arise from irregular muscular contractions in the fœtus, by which the bones are displaced, and the normal development of the joint is interfered with. In dislocations of the orbicular joints, after the head of the bone has been thrown out of its articular cavity, it is often still further displaced by the contraction of the muscles, which continues until they have shortened themselves to their full extent, or until the dislocated bone comes into contact with some osseous prominence that prevents its further retraction.

Signs.—The existence of a dislocation is rendered evident by the change in the shape of the joint, and in the relation of the osseous prominences to one another: by the articular end of the displaced bone being felt in a new position; and by an alteration in the length of the limb, and in the direction of its axis. Besides this, there are after a time, if not immediately on the occurrence of the accident, impaired motion of the injured articulation, and pain in and around it.

Effects.—The effects of dislocation on the structure of a joint are always serious. The bones that enter into the formation of the articulation are not unfrequently fractured as well as displaced, more particularly in hinge-joints; the cartilages may be injured, and the ligaments are always much stretched and more or less torn, the capsule of the joint suffering especially. In many cases, the muscles and tendons in the immediate neighborhood are lacerated as well as displaced, and the vessels and nerves compressed. The skin is commonly stretched, and sometimes ruptured, when the dislocation becomes *compound*. If the dislocation be a simple one, and if reduction be speedily effected, these injuries are soon repaired; and although a good deal of stiffness may continue about the joint, its functions are, in general, not permanently interfered with.

If the dislocation be left unreduced, important changes take place within and around the joint, in the bony structures, the ligaments, capsule, and muscles. The changes in the bony structures are very slow, differing in this respect materially in ordinary traumatic dislocations, from what takes place in a joint that has been dislocated as the result of disease. If the articulation be an orbicular one, as the shoulder or hip, the cavity, whether glenoid or acetabular, undergoes very gradual changes in outline and depth; its circumference becomes contracted, less regular, more angular, and it eventually shallows. These changes are so slow in the adult, that several years will elapse before they have gone on to such a degree as to prevent the displaced head of the bone from being put back. In children and young people they are more rapid and complete, and the cavity fills up with a dense fibrous deposit. In the hinge-joints, the articular ends of the displaced bones become altered in shape —flattened or angular, with the osseous projections less strongly marked. The incrusting cartilage is gradually absorbed, and the bone smoothed. The ligaments

are shortened and wasted; and a false joint forms around the articular end of the bone in its new situation. In some cases, the bone upon which the dislocated head rests becomes depressed into a shallow, cup-shaped cavity, so as to receive it; in others, the depression is formed by the elevation of a rim of callus upon the subjacent bone; and in both instances the areolar tissue in the neighborhood becomes consolidated into a fibroid capsule surrounding and fixing the bone in its new situation, and usually admitting of but a limited degree of motion. The soft structures that have been lacerated at the time of the dislocation become matted together by plastic material; the muscles shorten, atrophy, and at last undergo fatty degeneration from disease; the neighboring vessels and nerves may become attached to the new joint, or their sheaths become incorporated with the altered structures in contact with them.

Treatment.—In the treatment of dislocations, the first and principal indication consists in replacing the bone in its normal situation as speedily as possible. In doing this, the surgeon has two great difficulties to overcome: 1, the contraction of the muscles of the part; and, 2, the anatomical structure of the joint.

1. The great obstacle to reduction is, the tonic *contraction of the muscles* inserted into or below the displaced bones; and in the reduction of the dislocation the surgeon's efforts are chiefly directed to overcome this contraction. The longer the dislocation is left unreduced, the more powerful does this become; being less at the moment of the accident, and immediately afterwards, than at any subsequent period. Hence reduction should be attempted as soon as possible after the occurrence of the accident; and, if the patient be seen at once, the bone may sometimes be replaced without much difficulty by the unaided efforts of the surgeon. Thus Liston reduced a dislocated hip by his own endeavors immediately after the accident occurred. If a few hours have elapsed, the muscular tonicity becomes so great that special means must be adopted in order to diminish it; and if some weeks or months have been allowed to pass by, the dislocation may have become irreducible, partly owing to permanent contraction of the muscles which have been shortened by the approximation of their attachments, which contraction it is impossible to overcome, but chiefly to the cohesion of the surrounding tissues, and the formation of adhesions about the head of the bone.

In the reduction of a recent dislocation, advantage may sometimes be taken of the occurrence of faintness, or of the patient's attention being distracted to other matters, in order to effect the return, the muscles being then taken by surprise, and the bone readily slipping into its place. Such aids as these, however, cannot be depended upon; and muscular relaxation should be induced by the administration of chloroform or ether. By the employment of these valuable agents, the muscles of the strongest man may be rendered so perfectly flaccid and powerless in a few minutes as to oppose no action whatever to reduction, which has thus been wonderfully simplified and facilitated. In no department, indeed, of practical surgery has the administration of anæsthetic agents been attended by more advantageous results than in this.

Mechanical contrivances are much less frequently used for the reduction of dislocation now than formerly. It is, however, occasionally necessary to employ apparatus calculated to fix the articular surface from which the bone has escaped, and to draw down the displaced bone to such an extent that it may be replaced on the surface on which it should be lodged. If the patient have not been anæsthetized, it will be found that, when the bone is well brought down by the extending force so as to be opposite its articulation, being disentangled from osseous points upon which it may have hitched, it will be drawn at once into its proper position by the action of its own muscles, with a sudden and distinct snap; the muscles of the part being the most efficient agents in the reduction, so soon as the bone is placed in a position for them to act upon it. When, however, the patient has been placed under the influence of chloroform, the muscular system being thoroughly relaxed, the bone will not slip into its place with a snap or sudden jerk, but is reduced more quietly, and rather by the efforts of the surgeon than by any sudden contraction of its own muscles. It is important to note these differences in the mode of reduction; lest the surgeon, when chloroform has been fully administered, failing to hear the snap or feel the jerk which he expected, should imagine the bone not to be reduced, and continue an improper degree of extension.

The purely mechanical means for the reduction of dislocation are sufficiently

simple; the patient's body, and the articular cavity into which the luxated bone is replaced, are fixed by a split sheet, a jack-towel, a padded belt, or some such contrivance, by which *counter-extension* is practised. In some cases the hands of an assistant, or of the surgeon himself, or the pressure of his knee or heel, constitute the best counter-extending means.

Extension may be made either by the surgeon grasping the limb to be reduced and drawing it downwards, or else by means of a bandage or jack-towel fixed upon the part, with the clove-hitch knot applied in the way represented in the annexed cut (Fig. 141). If more force be required, the multiplying pulleys (Fig. 164), or the dislocation tourniquet invented by Mr. Bloxam (Fig. 165), may be used, by which any amount of extending force that may be required can readily be set up and maintained. The "adjuster" invented by Dr. Jarvis is a useful and powerful instrument for the same purpose. These contrivances, however, are much less frequently required now than formerly, owing to surgeons taking advantage of the paralyzing effects of chloroform upon the muscular system, and consequently not requiring so much force to overcome its contraction. When any powerful extending force is applied, the skin of the part should always be protected from being chafed by a few turns of a wet roller. The extension must be made slowly and gradually without any jerking, so as to secure equality of motion as well as of force. In this way the contraction of the muscles is gradually overcome, whereas sudden and forcible extension might excite them to reaction. The traction is most advantageously made in the axis which the limb has acquired in its new position, without reference to its normal direction or to the situation of the joint. In this way the head of the bone is made to pass along the same track which it has torn for itself in being dislocated, and thus is replaced without the infliction of any additional violence on the tissues around the joint.

Fig. 141.

Bandage applied for extension; clove-hitch knot.

The question whether the extending force should be applied to the bone that is actually displaced, or to the further end of the limb, has been much discussed, and appears to have received more attention than it deserves. It is true that, by applying the extending force to the displaced bone itself, the surgeon has greater command over its movements, with less chance of injury to the intervening bones; whilst, by applying the extending force to the lower part of the extremity, he has the advantage of a longer lever for the reduction of the head of the bone. This, lever, however, it must be remembered, is in many cases a broken one; and it cannot be made to act if the bone have to be replaced in the direction of the flexion of the joints that exist in its course. For this reason, we find that some dislocations are best reduced by applying traction to the bone itself that is displaced, as in luxations of the femur and of the bones of the forearm; whilst, in other cases, as in the dislocations of the humerus, most advantage is gained by applying the extending force to the end of the limb. But I look upon these points as of comparatively little consequence; believing that, when the patient is not anæsthetized, the muscles of the limb themselves effect the reduction without the necessity of the surgeon employing any very powerful lever-like action of the bone; and that, when the patient is paralyzed by chloroform, the bone is in most cases readily replaced by the simple movements impressed directly upon it, or even upon its articular end, by the hands of the surgeon.

The force required in effecting the reduction of recent dislocations is often very considerable. So great is the resistance offered by the muscles, that in some cases the dislocated bone has given way under the traction. I am acquainted with cases in which the humerus and the neck of the femur have both been broken in effecting the reduction of *recent* dislocations. This accident does not appear to have been the result of any improper or unskilful employment of force, but to have occurred from natural weakness of bone. We know that "spontaneous" fractures frequently take place from muscular action, often of a very slight kind: and we can easily

understand that, if a bone that would be liable to such ready fracture happened to be dislocated, it would almost of necessity give way under the influence of the extending or lever-like force required to replace it.

2. In reducing a dislocation, it is of especial importance to attend to the relation of the *osseous points in the neighborhood of the joint*, and to disentangle the displaced bone from any of these upon which it may be lodged. This is especially the case in such hinge-joints as the jaw and elbow, in which the arrangement of the articulation is somewhat complicated.

After the dislocation has been reduced, the bone must be retained in position by proper splints and bandages; the joint being kept quiet for two or three weeks, according to its size, so as to allow of proper union taking place in the capsule and neighboring structures. Any consecutive inflammation may often be prevented by the continuous application of cold; and, if set up, must be treated by local antiphlogistic means.

Dislocations of Old Standing.—If a dislocation have been left unreduced for some weeks or months, changes, which have already been described, take place in and around the displaced articular structures, the double effect of which is to render the replacement of the bones in their normal position more and more difficult as time goes on, and to lead to the formation of a new though imperfect articulation at the seat of displacement.

When a dislocation has been left permanently unreduced for a considerable length of time, as for years, the amount of utility in the limb will depend partly on the kind of joint that has been dislocated, partly on the particular variety of dislocation that has occurred. Thus, as a general rule, greater freedom of movement and greater utility of limb will be found in old-standing dislocations of ball-and-socket than of hinge-joints. But in ball-and-socket joints some dislocations will, if left unreduced, be attended with less evil consequences to the patient than others. Thus, in the *subglenoid* dislocation of the shoulder and the *sciatic* of the hip, the limb will recover itself to a greater extent than in the other forms of the same kind of injury affecting these joints.

Treatment.—In cases of very old and irremediable unreduced dislocation, much may be done by means of regularly conducted passive movements to increase the mobility of the part, and by means of friction and warm douches to relieve the tension and painful stiffness. In cases not so old, but in which some time has elapsed since the occurrence of the dislocation, two questions always present themselves to the surgeon: 1. Is it possible to replace the dislocated bone? 2. Is it desirable or prudent to attempt reduction?

The possibility of reducing the dislocation will depend partly upon the joint that is dislocated and the nature and extent of the dislocation, but chiefly on the length of time during which the bone has been out of place. Dislocations of the orbicular joints generally can be reduced at a much later period than those of the ginglymoid; those of the shoulder can be reduced after a longer lapse of time than those of the hip. The subglenoid dislocation of the shoulder and that of the hip on the dorsum ilii are susceptible of reduction at a later period than the other luxations of the same joints.

The *latest period* at which reduction is possible has been variously estimated by different surgeons. Sir A. Cooper gives three months for the shoulder and eight weeks for the hip. As a general statement, this was no doubt a tolerably correct one at the time that it was made, although reduction had been effected at later periods than those given by Cooper. Thus Breschet reduced a dislocation of the hip at the 78th day, and Travers at the fifth month. But we may now go far beyond this as the limit of *possible* reduction. Thus, Brodhurst has reduced the shoulder on the 175th day; Smith (U. S.) in one case at the seventh month, in another at ten months and a half; Blackman, of Cincinnati, a dislocation of the femur on the dorsum ilii at six months; and Dr. Dupierris, of the Havana, one at over six months, in a boy, and this without chloroform.

The *obstacles to the reduction* of old-standing dislocations are rather pathological, than physiological and anatomical as in the case of recent displacements. They are of several distinct kinds: 1. The powerful tonic contraction of the shortened and displaced capsular muscles. 2. The organic changes that have taken place in these muscles, arising partly from their cicatrization after laceration, partly from a kind of rigid atrophy, the consequence of inflammatory action and of disease. 3. Adhe-

sions that form between the lacerated capsule and muscles and the displaced head of the bone. 4. Lastly, as a more remote consequence than these, pathological changes taking place in the articulating surfaces themselves, by which their shape becomes altered and the socket shallowed, contracted, and perhaps ultimately obliterated by fibroid deposits.

In order to overcome these obstacles a considerable amount of force must be used, as adhesions and contractions have to be stretched and torn asunder. This is effected by the multiplying pulleys and by manipulation under chloroform. In employing the necessary force, care must be taken to protect the skin from abrasion, or even laceration, by the use of wet flannel bandages or wash-leather. The reducing force exercised by the pulleys must be considerable; but it should be accompanied with free rotatory manipulations and movements of the head of the bone, so as to loosen it from its adhesions; and it will usually be found to be replaced in this way rather than by forcible traction only.

Chloroform is of inestimable service in these cases; and it is by the anæsthesia produced by it that the surgeon has been enabled to prolong materially the limit of possible reduction. But, in the reduction of old dislocations, chloroform does not afford exactly the same kind of service as in those of recent date. In a recent dislocation the chief obstacle is muscular contraction; and, by relaxing this, chloroform enables the surgeon to replace the bone at once without difficulty. In old dislocations the obstacles, as has just been stated, consist in various pathological changes that have taken place around and in the displaced bones. These conditions cannot be influenced by anæsthesia; and hence, except as a means of producing insensibility to pain and preventing instinctive or voluntary muscular resistance on the part of the patient, chloroform will not aid the surgeon.

It must be borne in mind that the reduction of old dislocations is not only a work of very considerable difficulty, but also of no little danger. If several months have elapsed, the obstacles arising from the pathological changes already mentioned, will usually be of so obstinate a character, as to render the reduction impossible without the employment of a dangerous amount of force, and in many cases they will be of a nature to prevent the possibility of the accomplishment of reduction, whatever force be employed.

The *accidents* liable to occur during attempts to reduce old dislocations, whether successful or not, are the following: 1. Laceration of skin by the constriction and pressure of the bands to which the pulleys are attached. 2. Laceration of muscles: thus the pectoral has been torn through in attempting reduction of old dislocation of the shoulder. 3. The development of inflammation and suppuration around the dislocation, by the violence to which the soft parts have been subjected. From this cause death has several times resulted, in attempts at reducing old hip dislocations. 4. Extensive extravasation of blood from the rupture of small vessels in the lacerated soft parts, giving rise to wide-spread ecchymosis. 5. Laceration of one of the larger veins. A patient of Froriep's died from this cause, after rupture of the axillary vein, in an attempt to reduce an old dislocation of the shoulder. 6. Laceration of an artery, and the formation of a diffused traumatic aneurism. This serious accident has happened at least twelve times in attempted reduction of old dislocations of the shoulder. The brachial artery has also been torn in attempted reduction of dislocated elbow. 7. Laceration of neighboring nerves. Those of the axillary plexus have been torn in attempted reduction of dislocation of the shoulder, and the median in that of the elbow. 8. Fracture of the dislocated bone. This serious accident has usually happened when the surgeon, after the employment of extension, has attempted to put in force transverse movements of the bone, or has used it as a lever; when it has given way, usually high up near the head, at other times in the shaft. It is possible that in some cases this may have been predisposed to by the bone having become weakened by want of use. It has occurred several times in the humerus, and at least eight times in the femur, in attempts at reducing old dislocations of these bones. In most of the recorded cases the bone has readily united, and the condition of the patient has not been materially, if at all, influenced for the worse, except that reduction of the dislocation has necessarily been rendered impossible. 9. Neighboring bones have been fractured, such as the ribs and the glenoid cavity in the endeavor to reduce dislocation of the shoulder, and the acetabulum in attempted reduction of a luxated hip. 10. The limb has actually been torn off. This remarkable and distressing accident happened to M. Guérin, of Paris, in

attempting the reduction without pulleys, and merely by the traction of assistants, of a dislocation of the shoulder of three months' standing, in a woman 63 years of age, the limb suddenly and without warning being torn off at the elbow. On examination the bones were found porous, the muscular and other soft structures pulpy, the limb having thus evidently lost its natural strength and elasticity.

The occurrence of these various accidents and injuries, in the attempted reduction of old dislocations, cannot always with justice be attributed to the employment of an improper degree of force on the part of the surgeon. The liability to them must rather be looked upon as a necessary and inevitable accompaniment of all attempts at putting back into its place a bone which has been dislocated, and left unreduced for many weeks or several months. During this period it usually contracts adhesions of a very dense kind to the parts amongst which it lies; and, as it cannot be replaced in its articular cavity until these adhesions have been torn or broken through, it is easy to understand how, in the attempt to do this, neighboring soft parts, vessels or nerves, may give way, or the bone itself may yield to the force that must be applied to it in order to lift it out of its new bed.

The liability to the occurrence of these accidents should make the surgeon very cautious how he recommends the attempt at the reduction of old-standing dislocations. If after a time the new joint have become tolerably mobile, and be not painful, it may be better to leave the bone unreduced, rather than expose the patient to great risk, with a slender prospect of eventual success. If the unreduced dislocation be stiff and painful, much may be done by passive motion, frictions, and douches, to improve the patient's condition.

The *subcutaneous section* of muscles, tendons, and bands of adhesions in the neighborhood of the dislocated joint, has been proposed by Dieffenbach as a means of facilitating reduction in old-standing cases; and he relates an instance in which, by these means, a shoulder that had been dislocated for two years was reduced. In many cases in which this plan has been tried, the success has not been commensurate with the expectations raised respecting it; and in other instances, of which I have seen two or three, the operation has been followed by sloughing and other serious evils, while it has not been attended by any benefit in facilitating reduction.

Compound Dislocation is one of the most serious injuries to which a limb can be subjected. Not only is there such extensive laceration of the soft parts that cover and enter into the formation of the joint as to give rise to the most severe forms of traumatic arthritis, but the bones are often fractured, and the main vessels of the limb perhaps greatly stretched or torn.

The *treatment* of a compound dislocation must be conducted on the same principles that guide the surgeon in the management of a wounded joint; obtaining union, if possible, by the first intention, subduing inflammatory action, and letting out matter as it forms. Owing to the rupture of the ligaments and of the muscular attachments, there is usually no difficulty in the reduction, the bones being readily replaced; but the danger consists in the destructive inflammatory action that will be set up in the joint and limb from the extensive injury inflicted upon them. This varies greatly, according to the size and situation of the joint, and the state of the soft parts. If it be small, as one of the phalangeal articulations, the dislocation may be reduced, and the parts covered with cold lint. If it be one of the larger joints, the line of practice will vary according to other circumstances than the mere dislocation. Thus, if it be in the upper extremity, the patient being healthy, and the soft parts not very extensively contused or torn, the bones may be replaced, cold irrigation assiduously applied, and antiphlogistic treatment pursued. If there be fracture conjoined with the dislocation, resection should be practised, as was successfully done by Hey in several cases of injury of the elbow of this description; but if the soft parts be greatly injured as well, and especially if the bloodvessels and nerves of the limb have suffered, amputation must be performed. In the lower extremity, amputation is more frequently necessary; in the knee almost invariably so. Sir A. Cooper states that he knows no accident that more imperatively demands amputation than compound dislocation of this joint. Yet there are exceptions to this rule; thus, Mr. White had a case of compound dislocation of the knee-joint in a boy, nine years of age, at the Westminster Hospital, in which he saved the limb by sawing off the condyles of the femur and reducing the bone. In the compound dislocations of the ankle and the astragalus, an attempt should gene-

rally be made to save the limb, in the way that will be more specially pointed out when we come to treat of these injuries.

After recovery from compound dislocations, the joint will often remain permanently stiffened; hence attention to position during the treatment is essentially required. In many cases, however, very good motion is ultimately obtained, though the stiffness may continue for some length of time.

Complications.—*Fracture of the shaft of one of the long bones with dislocation of its head* increases considerably the difficulty of reduction. In these circumstances, it has been recommended to consolidate the fracture first, and then to attempt the reduction. But to do this is only to defer and increase the difficulties. At least seven or eight weeks must elapse before the fracture can be sufficiently firmly united to bear the requisite traction to reduce so old a dislocation; and then there will be great chance of rupture of the callus, and certainly extreme difficulty in the reduction. It therefore appears to me much safer, under all circumstances, to reduce the dislocation at once, and afterwards to treat the fracture in the usual way. In reducing a dislocation complicated with fracture of the shaft of the displaced bone, the fracture must first be put up very firmly indeed, with wooden splints completely encasing the limb. The patient must then be put fully under the influence of chloroform, which is of the most essential service in these cases; and, when the muscles are completely relaxed, extension and counter-extension being made in the usual way, the reduction may be effected. The extending means should always be applied upon the splints, so that there may be no dragging upon the fracture. In this way I have reduced, without any difficulty, a dislocation of the head of the humerus into the axilla, complicated with comminuted fracture of the shaft of the bone, in a remarkably muscular man to whom I was called by Mr. Byam; and about the same time I had a case of dislocated elbow, with fracture of the shaft of the humerus, under my care at the hospital, that was reduced with ease in the same way. The difficulty in reduction is necessarily increased by the proximity of the fracture to the dislocated joint; and when the epiphysis is broken off from the shaft and dislocated, the difficulty may be great, but is not insuperable. Some years since, I assisted Mr. H. Smith and Mr. Dunn in the reduction of a dislocation of the humerus with fracture of the surgical neck of the bone, the displaced head lying to the inner side of the coracoid process. In this case the patient, a young man who had sustained the injury by a fall in an epileptic fit, was put under chloroform, and when he was fully anæsthetized the displaced head of the bone was replaced at once and without any difficulty; the patient recovering with an excellent and useful arm. After the bone has been reduced, the fracture should be treated in the ordinary way.

When a *simple fracture extends into the articular end of the bone*, as in some dislocations about the elbow and ankle, there is no material increase in the danger of the case or in the difficulty of its management.

In *compound dislocation with fracture of the articular ends*, removal of splinters, and partial resection or amputation, will be required, according to the seat and extent of injury.

Spontaneous Dislocations may occur either suddenly or gradually, according to the nature of the cause that gives rise to them.

In many cases they result from the *destruction of the joint by old disease;* the ligaments and cartilages being destroyed by suppuration, the head of the bone becomes carious and absorbed, and the articular surfaces are displaced by ordinary muscular action. This we commonly see in old cases of hip-disease.

There is, however, another and more rare form of spontaneous dislocation to which the hip and shoulder are liable, and which has been especially studied by Mr. Stanley. In this dislocation the head of the bone slips out of the articulation without any very marked sign of disease about the joint, and certainly without any previous destruction of it. In these cases there is either a *paralytic condition of the capsular muscles*, as has been observed several times in the shoulder, the deltoid having become paralyzed and thus having allowed the bone to slip out of place; or, as has been noticed in the hip, *obscure rheumatic* or *neuralgic pains* have for some time been seated in the joint. The dislocation may not be confined to one joint, but may affect several. Thus, some time ago there was a case in University College Hospital, in which both shoulders and hips were dislocated simultaneously. In many cases it occurs suddenly, and often without any pain to the patient, the

deformity of the limb attracting attention to the accident, though in others it has been preceded by rheumatic affection of the joint.

The *treatment* of these cases is not very satisfactory. Reduction in many cannot be accomplished; while in others it may be effected readily enough, but the bone cannot be fixed in the joint out of which it slips again. In a case of spontaneous dislocation of the hip, without any apparent disease of the joint, occurring in a young woman, I readily effected reduction by the pulleys, three weeks after the occurrence of the displacement. The limb was then fixed with the long splint, and maintained at a proper length for two or three weeks; when, in consequence of a severe bronchitic attack, it became necessary to remove the apparatus, and the displacement speedily returned. Whilst convalescent from this attack, the patient fell and fractured the displaced femur in its upper third, thus rendering it impossible to replace the bone again. In another case of spontaneous dislocation of the knee, occurring in the same painless manner, the joint could not be replaced, and permanent deformity was left. After reduction in similar cases, a splint or a starched bandage should be worn for a considerable length of time, so as to give a chance for the ligaments of the joint to recover themselves. If there be a rheumatic tendency, it should be removed by suitable treatment; and if there be a paralytic condition of the muscles, electricity, the endermic application of strychnine, and cold douches with friction, may be advantageously employed.

Congenital Dislocations are occasionally met with in the hip, shoulder, wrist, and jaw, and have of late years attracted the attention of surgeons through the labors of Guérin, Smith, Chelius, Robert, and others. These dislocations are closely allied in cause and nature with other congenital deformities of the limbs, such as club-foot, &c. In them there is usually found arrested or imperfect development of some portions of the osseous articular apparatus. Whether this is original, thus causing the displacement of the bones, or consecutive upon disuse, occasioned by spasmodic action of one set of muscles or by paralysis of another, dependent on some irritation in the nervous centres, is scarcely worth inquiring here. In some cases it would appear as if faulty position of the fœtus in utero, or undue violence during birth, may have occasioned the displacement. These dislocations are probably incurable, as there is always congenital defect of structure in the articular ends of the bones.

CHAPTER XXI.

SPECIAL DISLOCATIONS.

Dislocations of the Lower Jaw are not common accidents. They occur more frequently in women than in men, and have been but very seldom met with at either extreme of life; but Nélaton and Malgaigne relate cases occurring in edentulous subjects of 68 and 72 years of age, and Sir A. Cooper has seen the accident in a child, occasioned by another boy thrusting an apple into its mouth. These dislocations are most frequently occasioned by spasmodic action of the depressor muscles of the jaw—by opening the mouth too widely, as in fits of laughing, of gaping, or in attempting to take too large a bite. Occasionally this accident has resulted from blows or kicks upon the chin, or from the violent strain upon the part in tooth-drawing, or rather in digging out stumps with an elevator. The mechanism of the dislocation is simple. When the mouth is opened, the interarticular fibro-cartilage with the condyle glides forwards on to the articular eminence: if this movement be continued too far, and the external pterygoid muscle contract forcibly at the same time, the condyle slips forward into the zygomatic fossa, the coronoid process hitching against the malar bone, the axis of the ramus being directed obliquely backwards, and the dislocation being thus complete. In this way both condyles may be displaced, or only one.

When the dislocation is *bilateral*, both condyles being displaced from the glenoid cavities, the signs are as follows: The incisor teeth of the lower jaw are separated from those of the upper by a marked interval; the mouth consequently cannot be

closed, but is kept more or less widely open. The extent of the separation between the incisor teeth varies from half an inch to an inch and a half. The degree will, I believe, depend on whether the coronoid process is fixed against the malar bone, or has slipped beyond this so as to admit of the displaced bone being received into the sigmoid notch. In the first case it would be considerably greater than in the second. Deglutition and speech are impaired, the labial consonants not being pronounced; there is dribbling of the saliva over the lower lip; the chin is lengthened, and the lower line of teeth advanced about half an inch beyond those of the upper jaw; the cheeks are flattened, and there is a depression in front of the meatus auditorius externus. There is also an oblong prominence in the temporal fossa between the eye and the ear. If the dislocation be left unreduced, the patient slowly regains some power of movement over the jaw; he gradually approximates the lips, and after a length of time, may even be enabled to bring the lines of teeth into apposition, especially posteriorly.

In the *unilateral* dislocation, where one condyle only is displaced, the axis of the lower jaw is directed towards the opposite side to that on which the displacement exists; and the general signs are the same, but in a less marked degree, as those which are met with when both sides are dislocated. The hollow before the meatus on the injured side is, however, well marked, and serves to point out the seat and nature of the displacement, the diagnosis of which is not always readily made; indeed, R. W. Smith states that he has seen attempts at reduction applied to the uninjured side.

Sir A. Cooper has described a *subluxation* of the jaw, most frequently met with in young and delicate women, in which, in consequence of the relaxation of the ligaments, the head of the bone appears to slip forwards upon the eminentia articularis, whenever the mouth is opened at all widely, as in gaping, laughing, &c. It may usually be ascertained by telling the patient to put out his tongue. The bone hitches, as it were, and prevents the mouth from being shut at once. Most commonly, the natural efforts of the part are sufficient to return the head of the bone into the glenoid cavity with a cracking noise or even a loud snap.

The *reduction* of a dislocated jaw is easily effected; it being only necessary to push the angle of the bone downwards and backwards, so as to disentangle the coronoid process from under the zygomatic arch, at the same time that the chin is raised by the surgeon's fingers, in order that the temporal and pterygoid muscles may draw the head of the bone into its proper position. The reduction is best effected by the surgeon standing before the patient and applying his thumbs, well protected by a thick napkin, to the molar teeth on each side, and thus depressing the angle of the jaw forcibly, at the same time that he raises the chin by means of his fingers spread out and placed underneath it. The bone is then returned into its place with so forcible a snap that, unless care be taken, or the thumbs be well covered up, they may be severely bitten. When one condyle only is luxated, the efforts at reduction should be applied to the injured side only.

After the reduction, the four-tailed bandage should be applied, as in cases of fracture of the jaw; and for several days the patient must not be allowed to talk, or to eat any solid food, lest the displacement return, which it always has a great tendency to do. Very old dislocations of this bone may be reduced by the process just now described. Thus, Stromeyer replaced one at the end of thirty-five, and Donovan one at the end of ninety-eight days.

In the cases of *subluxation*, attention should be paid to the state of the general health. Tonics, more particularly iron, should be administered; good diet, the cold bath, and open air exercise enjoined. If, as frequently happens, there be some tenseness about the temporo-maxillary articulation, a series of small blisters may be applied over it. It is of great importance to prevent the habit of recurrence of the dislocation. This may usually most conveniently be done by letting the patient wear a small silk cap fitted to the chin and attached by four elastic bands on the top of and behind the head, as in the case of a fractured jaw.

Congenital dislocation of one condyle of the lower jaw is a remarkable and rare condition, for an acquaintance with which we are chiefly indebted to R. W. Smith. In this condition there is a singular distortion of countenance. The osseous and muscular structures on the dislocated side are atrophied, and the teeth of the upper jaw project beyond those of the lower, contrary to what occurs in the accidental

dislocation; the mouth can be closed, speech is perfect, and there is no dribbling of saliva. Congenital dislocation of both condyles has not yet been observed.

Dislocations of the Clavicle.—When we look at the flat character of the sterno-clavicular articulation and the very small and shallow surface in the acromion upon which the outer end of the clavicle is received, and reflect on the violence to which the shoulder is frequently subjected, we might at first imagine that dislocations of the clavicle would be amongst the most frequent forms of injury in this region. But this is very far from being the case. They are, indeed, rarely met with in comparison to the frequency of fractures of this bone. This is owing to several causes: amongst these are the short and firm ligaments by which the clavicle is attached to the sternum and acromion, and the fact of any force that is applied to it being usually received in a line that corresponds to its axis, thus causing it to be bent or broken rather than luxated.

The mobility of the scapula, also, has a special tendency to prevent dislocations of the outer end of the clavicle, the two bones easily moving together. Were it not for this, the bone would frequently be thrown off the small flat articular surface of the acromion.

Dislocations of the clavicle can only be occasioned by violence applied to the shoulder in such a direction, as to drive the bone inwards towards the mesial line, at the same time that the scapula is fixed.

Either the sternal or the acromial end of the clavicle may be dislocated, and the simultaneous displacement of both has even been observed.

1. The *sternal end of the clavicle* may be luxated in a direction *forwards*, *backwards*, or *upwards*, being thrown before, behind, or above the sternum.

In the dislocation *forwards*, the end of the bone can be felt in its new position, the point of the shoulder is approximated to the mesial line, and the depressions above and below the clavicle are strongly defined. It is occasioned by blows upon the shoulder, by bending this part forcibly backwards, or by violence applied to the elbow whilst the arm is raised from the side. In some cases it occurs spontaneously without the application of external violence, as a secondary consequence of lateral curvature or rotation of the upper dorsal vertebræ.

This dislocation, which is amongst the most frequent to which the clavicle is subject, may readily be *reduced* by pushing the shoulder outwards and bending it backwards. The principal difficulty in the treatment consists in preventing the return of the displacement, owing to the shallowness of the articular surface upon which the clavicle lodges. With this view a pad and a figure-of-8 bandage must be firmly applied upon the displaced end of the bone.

The dislocation *upwards* is of extremely rare occurrence. The signs in the two recorded cases were so evident as not to lead to any difficulty in the diagnosis of the accident, the projection of the sternal end of the clavicle in its new situation being subcutaneous, and at once cognizable to the touch. In the *treatment*, a bandage and pad, with elevation of the elbow, brought the bone into good position.

The dislocation *backwards* is not of common occurrence; though, according to Nélaton, there are at least ten or a dozen cases on record. This luxation appears generally to have resulted from the point of the shoulder being driven upwards, or from the hand being violently drawn forwards. It has also been observed to result from the direct pressure of the clavicle backwards, as by the kick of a horse, and has occurred as a secondary consequence of curvature of the spine.

The *signs* are those that usually attend a dislocation of the sternal end of the clavicle—shortening of the shoulder, and deformity about the upper part of the sternum; but, besides these, a special train of symptoms is occasioned, by the pressure of the displaced bone upon the trachea, œsophagus, and vessels of the neck. Difficulty in breathing and swallowing, with congestion of the head giving rise even to a semicomatose state, may be produced to such an extent as to require removal of the end of the bone, as happened in a case related by Sir A. Cooper, in which the surgeon was obliged to saw off the dislocated end. In some cases, the end of the bone is thrown upwards as well as backwards; in others, it takes rather a downward direction.

In the *treatment* of this dislocation, it is easy to effect the reduction of the bone by making a fulcrum of the fist in the axilla, and then bringing the elbow well to the side, at the same time that an assistant puts his knee between the patient's shoulders and bends them back; but it is difficult to retain the bone in proper posi-

tion. To fulfil this object, the figure-of-8 bandage tightly applied to the points of the shoulders, and crossed over a large pad placed in the middle of the back, will give the most efficient support to the part, the elbow being at the same time well fixed to the side and drawn back.

2. The dislocations of the *outer end of the clavicle* are more commonly met with than those just described. The most frequent accident of this description is that in which the bone is thrown *upon the upper surface of the acromion*, or *upon the anterior part of the spine of the scapula*. In several cases of this accident which have of late years presented themselves at University College Hospital, there has been no difficulty whatever in the diagnosis. The prominence formed by the displaced bone upon the upper surface of the acromion, the narrowing of the distance from the mesial line to the point of the shoulder, the facility of the reduction of the dislocation, and the tension of the clavicular portion of the trapezius muscle, indicate the nature of the accident (Fig. 142). The *treatment* of this injury is by no means satisfactory. Reduction may easily be effected by raising the shoulder, drawing it backwards, and carrying it outwards by placing a pad or the hand in the axilla and bringing the elbow well to the side. But, notwithstanding the facility of reduction, there is in many cases a great and, indeed, an unconquerable tendency to the return of the displacement. This is partly owing to the shallowness of the articular surface of the acromion, partly to the tension of the trapezius, by which the acromial end of the bone is drawn upwards and outwards, and in a great degree to the mobility of the shoulder. Reduction is best maintained by the application of an axillary pad, and the same method of treatment as in fracture of the clavicle (Fig. 112).

Fig. 142.

Dislocation of the clavicle on the acromion.

In every movement of the body or neck there will be found to be a tendency to rising upwards of the end of the dislocated bone, and in the majority of cases this will be found to be insurmountable by any mechanical means that can be employed. It is best limited, if not obviated, by a pad and gutta-percha plate laid on the projecting clavicle, and strapped tightly down by a band passing parallel to the arm and under the flexed forearm, this being retained in position by being attached to a strap passed round the opposite axilla. If the displacement continue to be irremediable, a very useful arm will still be left, only somewhat limited in its upward movements.

The outer end of the clavicle has been dislocated *under the acromion* by the application of direct violence to the end of the bone. This form of displacement is very rare; several instances have, however, been mentioned in the journals. The diagnosis is easy, simple digital examination pointing out the nature of the accident; and the treatment must be conducted in the same way as that of fractured clavicle.

The acromial end of the clavicle has been known to be displaced *underneath the coracoid process*. Here, also, simple examination and the clavicular bandage suffice for diagnosis and treatment.

The only instance of *simultaneous dislocation of both ends of the clavicle* with which I am acquainted has been reported by Richerand.

Dislocation of the Scapula.—The *lower angle and dorsal border of the scapula* is occasionally the seat of a very remarkable kind of displacement, in consequence of which it projects at a considerable angle from the trunk, giving a winged appearance to the back.

The cause of this peculiar displacement is somewhat obscure: by some it is considered to be dependent upon the bone slipping away from under the posterior edge of the latissimus dorsi muscle; by others, again, and apparently with more reason, it is regarded as owing to paralysis of the serratus magnus. Whether this be dependent upon some morbid condition of the muscle itself, as Dr. Jacob supposes, or on a paralyzed state of the long thoracic nerve, as Nélaton thinks, can scarcely be determined. In such cases as these, I have seen some benefit derived from the endermic application of strychnine on a blistered surface, and afterwards support by means of a properly constructed apparatus.

Dislocations of the Shoulder-joint occur far more frequently than those of any other articulation. Their pathology and treatment have been so clearly elucidated by Sir A. Cooper, that there is little left for subsequent writers but to follow the descriptions given by that great surgeon; though several of the modern French surgeons, especially Velpeau, Malgaigne, and Goyrand, have thrown some new light on the subject. The reason of the frequency of these dislocations is to be found in the shallowness of the glenoid cavity, the large size and rounded shape of the head of the humerus, and the weakness of the ligaments; but, above all, in the extent and force of the movements to which the joint is subjected. These displacements indeed would be much more frequent than they even are, were it not for the protection afforded to the joint by the osseous and ligamentous arch formed by the coracoid process and acromion with their ligaments, the great strength of the capsular muscles and their close connection with the joint, and the support given by the tension of the long head of the biceps over its weakest part; but the principal obstacle to dislocation is the mobility of the scapula, enabling all movements communicated to the hand and arm to react upon that bone.

The *signs* of dislocation of the shoulder-joint are sufficiently obvious, varying, however, according to the nature of the injury. In all cases there are six common signs, viz.: 1, a flattening of the shoulder; 2, a hollow under the acromion; 3, an apparent projection of this process, with hollow tension of deltoid; 4, the presence of the head of the bone in an abnormal situation; 5, rigidity; and 6, pain about the shoulder.

The shoulder-joint is susceptible of *four* dislocations. Of these, according to Sir A. Cooper, three are complete, and the fourth partial. I think, however, that on examination it will be found that the so-called *partial* dislocation is in reality a complete one. The directions in which the head of the humerus may be thrown are—1, *inwards and slightly downwards* beneath the coracoid process (Fig. 145); 2, *forwards and inwards* beneath the clavicle (Fig. 144); 3, *backwards and downwards*

Fig. 143. Fig. 144. Fig. 145. Fig. 146.

DISLOCATIONS OF THE HEAD OF THE HUMERUS.

Subglenoid. Subclavicular. Subcoracoid. Subspinous.

under the spine of the scapula (Fig. 146); 4, *downwards and slightly inwards* under the glenoid cavity (Fig. 143). Thus three dislocations are more or less inwards, one only being backwards or outwards.

1. *Subcoracoid Dislocation.*—In the case of *incomplete* dislocation reported by Sir A. Cooper, the head of the bone was found to be thrown out of the glenoid cavity, lying under the coracoid process upon the anterior part of the neck of the scapula (Fig. 145); the capsular muscles were not torn, but the long head of the biceps had been ruptured. The description given by Sir A. Cooper, and the illustrative plate in his work on *Dislocations*, appear to point to a form of injury of the shoulder-joint which has of late years been specially described by the French surgeons as a variety of the dislocation downwards; that form of displacement, indeed, which by Boyer has been described as the dislocation "inwards," by Malgaigne as the "subcoracoid" luxation, and by Velpeau as the "subscapular" dislocation; in which the head of the humerus is placed in front of the neck of the scapula, and underneath the subscapular muscle. In this dislocation the head of the bone, instead of being thrown, as in the subglenoid, downwards and slightly inwards, is

thrown inwards either directly or slightly downwards as well. Why Sir A. Cooper described this as a *partial* dislocation, I do not understand; for not only was there rupture of the capsule and of the long tendon of the biceps, but the wood-cut at page 401 of the last edition of his work shows clearly that the head of the bone had formed a new articular cavity for itself in the subscapular fossa, being apparently completely thrown out of the glenoid cavity.

There is here less deformity than in the other luxations, the acromion not forming so distinct a projection (Fig. 147). The limb is usually somewhat lengthened, but at times is actually shortened, the elbow being usually carried backwards and always slightly away from the side; the head of the bone is placed deeply in the upper and inner part of the axilla, and cannot always be very distinctly felt, owing to its being thickly covered with soft parts, by the coraco-brachialis as well as by the pectorals; rotation of the arm and elevation of the elbow being usually required in order that it may be detected.

Fig. 147.

Subcoracoid dislocation of humerus.

2. In the dislocation *forwards*, or the *subclavicular* (Fig. 144), the head of the bone is thrown on the inner side of the coracoid process, lying upon the second and third ribs under the pectoral muscles, and immediately below the clavicle. This dislocation is merely an increased degree of the preceding one, the head of the bone, which at first lies under the coracoid process, being readily drawn inwards, so as to be placed to the inner side of this process under the clavicle. In these cases the capsular muscles are much stretched or torn. In a case recorded by Mr. Curling, the infraspinatus and subscapularis muscles were torn away from the tubercles of the humerus, and the teres minor partially lacerated; the capsule being completely separated from the neck of the bone, which pressed forcibly upon the axillary vessels and nerves. In three cases which I have had an opportunity of dissecting and examining after death, the great tubercle was torn away from the head of the bone, with much laceration of the capsule and extensive extravasation, but the external rotator muscles were not ruptured in two instances; whilst in the third the supraspinatus, the infraspinatus, and the teres minor, were all torn across near the insertions into the humerus. In fact, in these cases it appears to be a question of strength between muscle and bone; either the muscles are torn across, or the great tubercle, into which they are inserted, is torn away from the shaft of the bone, leaving its attached muscles unruptured.

In this dislocation, the head of the humerus can be felt and seen under the pectoral muscles beneath the clavicle; the arm is shortened, the axis of the limb being directed towards its head, and the elbow is a good deal separated from the side and thrown back.

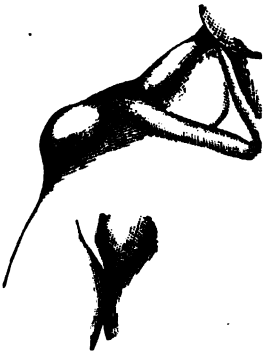
3. In the dislocation *backwards*, or the *subspinous* (Fig. 146), the head of the humerus lies behind the glenoid cavity, and below the spine of the scapula, between the infraspinatus and teres minor muscles. Mr. Key found the tendon of the subscapularis torn across, together with the internal portion of the capsular ligament; the supraspinatus and the long head of the biceps being stretched, but not ruptured.

When the head of the bone is dislocated below the spine of the scapula, it can be felt and seen there, more especially when the arm is rotated. The axis of the limb is altered, being directed backwards nearly horizontally; the elbow is raised from the side, to which it cannot be approximated, and is carried forwards and somewhat downwards.

4. In the dislocation *downwards*, or the *subglenoid* (Fig. 148), the head of the bone lies in the axilla, resting against the inferior costa of the scapula below the glenoid cavity, and lodged between the subscapular muscle and the long portion of the triceps. In it the tendon of the subscapular muscle is commonly torn near its insertion into the lesser tubercle of the humerus, and the capsular ligament is largely lacerated. The supraspinatus muscle may also be torn through, or a portion of the great tubercle of the humerus detached, and the rest of the capsular muscles put greatly on the stretch. The axillary artery and plexus of nerves are compressed and stretched by the dislocated head of the bone, so that a severe numb pain is

commonly experienced in the hand and arm. The compression of the artery is so great, that the circulation through the limb is completely arrested. This I saw remarkably illustrated in a patient under my care who had a dislocation downwards of the head of the humerus, with a severe lacerated wound of the forearm, dividing the radial and ulnar arteries. So long as the dislocation remained unreduced, no hemorrhage took place; but so soon as the head of the bone was replaced, the injured arteries bled freely.

Fig. 148.



Subglenoid dislocation.

The head of the bone can usually be readily felt in the axilla, at its anterior and under part; the arm is lengthened to the extent of about an inch, the forearm is usually somewhat bent, and the fingers are often numbed, in consequence of the pressure of the head of the bone on the axillary plexus. The elbow is separated from the trunk and carried somewhat backwards, but can be approximated to the side. If the head of the bone cannot be felt in the axilla, its presence there may be ascertained, as Cooper directs, by raising the elbow, when it at once becomes perceptible.

It appears to me that the only dislocation of the humerus to which the term *partial* is strictly applicable, is that which has been described by Mr. Soden, in which the long tendon of the biceps is displaced from its groove or ruptured, and the head of the bone is thrown upwards and forwards under the coracoid process, but not out of the glenoid cavity. It is to this form of displacement also that Mr. Callaway seems disposed to confine the term *partial*.

In this partial dislocation the *signs* do not appear to be very evident. In Mr. Soden's case there was slight flattening of the outer and posterior parts of the joint, and the head of the bone appeared to be drawn higher up in the glenoid cavity than usual. There was great pain induced by any movement of the biceps muscle; and, on attempting any overhand motions, the head of the bone became locked by the acromion.

Causes.—Dislocations of the shoulder-joint are almost invariably the result of falls upon the hand or elbow; the particular variety of dislocation depending upon the direction of the shock communicated to the arm, and the position of the limb at the time of receiving it. On this account we almost invariably find the displacement in a direction inwards and downwards. When a person saves himself in falling with his arms widely stretched out, the head of the bone is driven with all the force of a long lever against the lower and inner portion of the capsule, which, being ruptured in this its weakest part, allows the bone to be thrown upon or to the inside of the inferior costa of the scapula, and thus into the axilla. When the patient falls upon his elbow, the inner part of the joint is still acted on; but, the leverage not being so great, the head of the bone is thrown upwards or forwards under the clavicle. This dislocation is also often the result of direct violence applied to the shoulder.

The dislocation backwards can only take place when the arm happens to receive the shock at the time when it is stretched across the chest. As this is an unusual position for any injury to be received in, this dislocation is proportionately rare. An obstacle to this displacement may also be found in the great strength of the outer portion of the capsule of the joint, as compared with the inner.

Relative frequency.—Sir A. Cooper states that the dislocation "into the axilla" is the more frequent form of accident. This opinion is supported by that of most English surgeons. Malgaigne, and more recently Mr. Flower, have expressed the opinion that the subcoracoid is the most common form of this accident. Mr. Flower, who has very ably investigated this subject, finds that of forty-one specimens in the different London Museums, thirty-one are undoubtedly *subcoracoid*, and that, of fifty recent cases of which he has cognizance, forty-four were of this form. Next in order of frequency comes the *subglenoid*, and then the *subclavicular*, which is somewhat rare. I believe that the subclavicular is, as it were, an exaggerated degree of the subcoracoid; the continuance of the same force, whether mechanical or muscular, which had thrown or drawn the head of the bone to the inner side of the coracoid process, carrying it upwards under the centre of the clavicle. The displacement of

the head of the bone under the spine of the scapula is so rare, that Sir A. Cooper met with two cases only of it; several cases have occurred at the University College Hospital, which were reduced without difficulty.

Diagnosis.—Dislocations of the humerus may readily be diagnosed from *fractures of the anatomical and surgical neck* of the bone, by the existence of the signs which are common to all luxations, and by the absence of crepitus. In fractures in this situation, also, the glenoid cavity always continues to be occupied by the head of the bone. The existence of crepitus, of slight shortening, but little alteration in the axis of the limb, and no correspondence between this and the position of its head, are additional signs of value in establishing the diagnosis. The nature of the accident that occasions the injury is often an important element in the diagnosis. Fractures of the upper end of the humerus can only occur from direct violence applied to the shoulders. Dislocations, on the other hand, are almost invariably the result of indirect violence applied to the hand or elbow. Hence the injury resulting from a fall or blow on the shoulder itself is almost invariably a fracture; that from a fall on the hand or blow on the elbow a dislocation of the humerus. *Paralysis of the deltoid from a blow* may simulate a dislocation, the shoulder being flattened and the acromion projecting: but here the mobility of the joint, and the presence of the head of the bone in the glenoid cavity, establish the absence of dislocation.

The *reduction* of a dislocated humerus may be conducted on three different plans: *by the heel in the axilla; by the knee;* or *by drawing the arm upwards.* Whichever plan is adopted the patient should, if strong, be put under the influence of chloroform; when his muscles are paralyzed by this agent but little force is required to effect the reduction, the surgeon's unaided strength usually sufficing for this purpose. If more power, however, should be required than he can exercise, extension may be made by assistants drawing upon a towel properly fixed round the lower end of the humerus, or else by the pulleys attached to the same part of the limb.

1. The reduction of the dislocation *by the heel in the axilla*, is certainly the easiest procedure in ordinary cases. In adopting this plan, the patient is laid upon his back upon a low bed or couch; the surgeon, seating himself upon the edge of this on the same side as the dislocated arm, takes the limb by the wrist, and, fixing one foot firmly upon the ground, places the other, merely covered with the stocking, well up into the axilla, so that the heel may press against the lower border of the scapula, and the ball of the foot act upon the humerus (Fig. 149). He then draws

Fig. 149.

Reduction of dislocated shoulder-joint, by the heel in the axilla.

the limb steadily downwards, and, when it is disengaged to a sufficient extent, brings the hand across the patient, using his foot as a fulcrum, by which the head of the bone may be reduced by being pushed upwards and outwards. This mode of reduction is especially serviceable in ordinary dislocations into the axilla, and in those under the clavicle. In the latter, however, it will be necessary to draw the

arm more obliquely downwards and backwards, and to press the foot somewhat forwards upon the head of the bone, after it has been disengaged by being brought below the coracoid process.

2. The reduction *by the knee in the axilla* is precisely the same in principle as the last, though not by any means so good a plan; the knee being too large and not following the movements of the humerus so readily as the foot. In effecting the reduction by this means, the patient is seated on a chair; and the surgeon, standing by his side and resting one foot upon the seat, places his knee in the axilla. He then seizes the patient's arm above the elbow with his right hand, and, steadying the acromion with his left, draws the limb well down, and brings it across the knee: the head of the bone is thus reduced.

3. In some cases reduction is easily effected by laying the patient on his back, when the surgeon, sitting behind him, *raises the arm perpendicularly* by the side of the head, at the same time that he fixes the acromion. In this way the head of the bone is brought directly upwards into the glenoid cavity.

[I am in the habit of reducing recent dislocations of the shoulder by raising the arm directly upwards, and then bringing it down well extended, in a broad sweep over the closed fist of an assistant placed in the axilla to act as a fulcrum. Another and a very ingenious mode of reduction by manipulation has been described by Prof. H. H. Smith of this city. (*Am. Journ. Med. Sciences*, April, 1858, p. 345.)—A.]

If the patient be very muscular, or the dislocation of old standing, it may be necessary to have recourse to the *pulleys* in order to effect reduction. In applying these the scapula must be firmly fixed, the counterextension being made by passing the patient's arm through a slit in the middle of a jack-towel, which should be fixed firmly to a hook or staple in the wall. The extending force may then be applied immediately above the elbow; and traction being made slowly and steadily in the direction of the axis of the limb. The head of the bone should be directed to the glenoid cavity by the pressure of the surgeon's hands, so soon as it has come on a level with it. In this way dislocations of the humerus of many weeks' or even months' standing have been successfully reduced; but in employing these powerful means, especially under the influence of chloroform, the surgeon should always bear in mind that, unless care be taken, serious mischief, even laceration of the axillary artery, may result. After dislocation of the humerus has been reduced, the limb should be bandaged to the side and supported in a sling; and if inflammation occur about the joint, recourse may be had to leeches and evaporating lotions.

After reduction, there is a tendency for the head of the bone to be drawn upwards and outwards under and against the acromion, owing evidently to the deltoid and coraco-brachialis muscles not being any longer counterbalanced in their actions by those that have been separated from the head of the bone.

Compound dislocation of the head of the humerus is a rare accident. I have, however, seen two cases of it, and in two directions: downwards—*subglenoid*, and inwards—*subcoracoid*. In both cases reduction was effected, and the patients did well. In it, even though the injury be extensive, it is better not to amputate if the axillary vessels and nerves be uninjured. The limb may be saved by reducing the bone at once; after this the wound should be closed and dressed lightly, and kept cool by constant irrigation. If the axillary artery be ruptured at the same time, either completely or through its inner and middle coats, obstruction to the arterial circulation of the arm will ensue, and amputation must be performed through the articulation.

Complications.—A *simple dislocation of the head of the humerus, with rupture of the axillary artery* and the formation of a diffused axillary aneurism, is a condition of things as serious as it is fortunately rare. In a case of this kind, Dr. R. Adams, after reducing the dislocation, ligatured the subclavian artery, the patient recovering; and this would be the proper practice to pursue in similar cases.

A very serious accident, and apparently difficult to treat, consists in the complication of a *dislocation of the humerus with fracture through the epiphysis* of the displaced bone. A case of this kind, to which I was called, is described at page 296.

When the dislocation is complicated with a *fracture of the shaft of the bone*, it should be reduced at once by putting the fracture up very firmly, and then attempting the reduction by one of the usual methods. In the cases to which I have

already referred (pp. 295–6), I succeeded without difficulty by means of the heel in the axilla. The fracture must then be treated by lateral splints.

Congenital dislocations of the shoulder-joint have only of late years attracted attention. Dr. R. W. Smith has ascertained, by *post-mortem* examination, the existence of two varieties of this condition—the *subcoracoid* and *subacromial* luxations. In these there is wasting of the muscles of the shoulder and arm, the motions of which are extremely limited, whilst those of the scapula are preternaturally great. The condition of the bones is also remarkable. In a case of congenital subacromial luxation of both shoulders, there was no trace of a glenoid cavity; but a well-formed socket existed on the outer side of the neck of the scapula, receiving the head of the humerus, which was small and distorted. These dislocations, though existing from birth, usually become more marked as age advances, but are necessarily irremediable, in consequence of the malformation of the osseous structures and the wasting of the muscles.

Old unreduced dislocations of the head of the humerus are not unfrequently met with. In the majority of these cases there is a considerable amount of pain and immobility about the shoulder at first; but after a time the head of the humerus forms a new bed for itself, and the movements of the arm become freer and less painful, so that eventually a limb useful for all except the overhead movements will result.

In cases of old dislocation of the head of the humerus, the question as to the advisability of attempting reduction always presents itself to the surgeon. As a general rule this should always be attempted under chloroform, in accordance with the principles laid down at p. 293, if only a few weeks have elapsed from the time of the accident, and then it will usually be attended with success. Reduction has been effected in many cases at a much later period than this; by Mr. Brodhurst, after twenty-five weeks had elapsed; and by Dr. Smith, U. S., after no less a period than seven months in one case, and ten and a half in another. By the use of the subcutaneous division of muscles, &c., Dieffenbach is said to have succeeded in reducing a dislocation of the shoulder after it had existed two years. In many cases, however, at a much earlier period than these, the surgeon will fail, notwithstanding the most persevering attempts at reduction; and in others again certain accidents have occurred, which every surgeon should bear in mind, so as to render him cautious in his proceedings.

The *accidents* that have occurred in attempts at reducing old-standing dislocations of the head of the humerus are such as may arise either from the employment of an undue amount of force, from the separation of the head of the humerus from the adhesions that it has contracted in its new situation, or from pathological changes that have taken place in the limb itself. Amongst the first are laceration and bruising of the skin, subcutaneous areolar tissue, and muscles, with extravasation of blood: amongst the latter are fracture of the humerus, laceration of the axillary vessels and nerves, and avulsion of the limb.

Fracture of the humerus has occurred in the practice of many surgeons of eminence. It has happened to Petit, Pott, Larrey, Bérard, Denonvilliers, and others. The surgical neck of the bone appears to be the part that has usually given way; and the accident has not occurred so much from forcible extension, as in carrying the arm across the chest so as to tilt the head of the bone into its place, when the shaft becomes exposed to fracture by pressure in a transverse direction. The occurrence of such an accident as this necessarily prevents all further attempt at reduction.

Fracture of the ribs, by the pressure exercised against the wall of the chest, is supposed to have occurred in some cases.

The *extravasation* of a large quantity of blood into the areolar tissue of the axilla has occasionally occurred, without any evidence of the rupture of one of the main vessels of the part. In these cases the swelling has gradually subsided under the employment of ordinary treatment, by rest and evaporating lotions.

More serious by far than this is the *rupture of one of the large bloodvessels* in the axilla. This may happen in two ways: either by the pressure of the surgeon's heel, as happened in a case reported by Hamilton, in which an attempt had been made to reduce a dislocation of old standing by this means; the surgeon unfortunately forgetting to remove his boot, and thus contusing and lacerating the artery. Or, it may occur from the humerus having become adherent to the vessel,

and lacerating this when torn away. The instances on record of *laceration of the axillary artery*, and the consequent formation of a diffuse *traumatic aneurism* in the axilla, in the reduction of old dislocations, are so numerous—there being at least twelve cases in the records of surgery—as to act as a warning to the surgeon not to employ too much force in cases of this kind.

In the great majority of these cases—in at least ten out of the twelve—the diffused traumatic aneurism appeared immediately after the employment of forcible and long-continued extension. In the remaining two instances, the aneurismal tumor did not appear until after the lapse of time. In Dupuytren's case a woman, sixty years of age, had a dislocation into the axilla of six weeks' standing reduced. Two or three months after this, a tumor appeared in the armpit. This was mistaken for an abscess, and opened; arterial hemorrhage ensued, and the patient died on the eighth day, from secondary bleeding. In Nélaton's case the patient, also an old woman, had a subglenoid dislocation which was easily reduced. But an aneurism appeared in the axilla, which, three months after the reduction, compelled that distinguished surgeon to tie the subclavian. Both these aneurisms were probably circumscribed.

Dupuytren's case was not the only one in which the fatal mistake was committed of opening the aneurism in the axilla—the same was done by Pelletan, who mistook the tumor for an emphysema; the result being of necessity fatal. In cases reported by Verduc, Petit, Platner, and Leudet, the aneurism was allowed to run its course unchecked by efficient surgical treatment, and in every instance proved fatal by the sac giving way, and secondary hemorrhage ensuing. Sir C. Bell records a case that occurred at the Newcastle Infirmary, in which the pectoral muscles as well as the artery were torn, and immediate amputation became necessary. In four cases the subclavian artery has been ligatured. All these happened in America; two to Gibson, one to Blackman, of Cincinnati, and one to Warren. Three of these cases proved fatal by secondary hemorrhage, Warren's being the only one in which recovery took place.

What *treatment* should be adopted in this distressing accident? If the aneurism be left to itself, or be treated by inefficient means, it must necessarily prove fatal by its rupture or sloughing and secondary hemorrhage. The ligature of the subclavian is not very promising, as a fatal result occurred in three out of the four cases in which it has been tried for diffuse aneurism, Nélaton's case having been circumscribed. Under these circumstances, it appears to me that it would be wiser to apply to these cases the usual principle of treatment that is adopted in cases of diffused axillary aneurism from other causes; viz., to compress the subclavian, lay open the sac, turn out coagula, and tie the torn artery at the seat of injury.

In one case, the dislocation being of twenty days' standing, and the patient a female 26 years old, Froriep states that reduction was followed by sudden and extensive tumefaction of the axilla, syncope, and death in an hour and a half. A *post-mortem* examination disclosed *laceration of the axillary vein*. No mention is made of any internal injury to account for death.

Injury to the *axillary nerves* during reduction leading to paralysis of the arm has also been described.

Besides these accidents, other evil consequences have occasionally followed prolonged attempts at reducing old dislocations of the humerus, such as sudden death from *syncope* and *exhaustion*. Guérin's remarkable case of *avulsion of the limb* at the elbow in a woman 63 years of age, in an attempt to restore a dislocated humerus three months after the luxation had occurred, is an instance of an accident that is as yet unique in the records of surgery. In this case no undue amount of force seems to have been used, but the tissues of the limb had become softened and porous—partly probably from disuse, partly from senile changes.

In the event of the surgeon being unsuccessful in his attempts at reduction, he must endeavor, by means of frictions and passive motion, to restore, as far as practicable, the utility of the limb. In some of these cases of old unreduced dislocation, I have succeeded in very materially improving its condition by putting the patient under the influence of chloroform, and moving the limb freely to and fro so as to loosen, stretch, and break up the adhesions about the head of the bone; and it is in this way that attempts at reduction, even though unsuccessful in replacing the head of the bone, are often of great use in improving the mobility of the limb.

Dislocations of the Elbow are by no means unfrequent accidents; and, as they are often occasioned by direct violence, in consequence of which much swelling speedily sets in, their signs are frequently obscured, and the diagnosis is rendered proportionately difficult; more especially when the dislocation happens to be complicated with fracture of the articular ends of the bones. In these cases, indeed, it is only by a correct acquaintance with the normal relations of the osseous points, and by a comparison between those of opposite sides, that the surgeon can detect the true nature of the injury.

The *varieties* of dislocation of the elbow-joint are very numerous, either both bones of the forearm or only one being implicated.

1. *Both Bones.*—The most common dislocation is that in which both bones are thrown *backwards*, with or without fracture of the coronoid process. This injury is readily recognized by the projection backwards of the olecranon, carrying with it the tendon of the triceps. The articular end of the humerus also can be felt projecting in front of the elbow. When the coronoid process is not broken off, it is fixed against the posterior surface of the humerus, the forearm being immovably placed in its new position. When this process is fractured, there is great mobility about the joint, and crepitation may be felt as the arm is drawn forwards.

Dislocation of both bones *forwards* can scarcely occur without fracture of the olecranon. Rare as this accident must be, there are at least four cases on record by Colston, Lana, Delpech, and Canton, in which the bones have been so displaced without this process being broken. In this injury the elongation of the forearm, the projection of the condyles of the humerus, the presence of the sigmoid notch in front of the arm and the depression of the posterior surface of this bone, render the diagnosis sufficiently easy. In one case which occurred at University College Hospital in 1867, the accident occurred by the patient, a man 20 years of age, slipping on the pavement and falling on his elbow. In this instance the elbow was much bent; it could be brought to a right angle, and straightened considerably. The forearm was three-quarters of an inch longer than its fellow. The condyles of the humerus were on a level with the olecranon; the tendon of the triceps was very tight, and the sigmoid notch could be plainly felt on the fore part of the arm. The head of the radius could also be felt in front of the humerus. When the olecranon is broken off, there is elongation of the forearm and great mobility, but the detached fragment can be felt behind the humerus.

The *lateral* dislocation of the bones of the forearm is almost invariably incomplete, either the head of the radius hitching against the internal condyle, or the ulna coming into contact with the external one. Complete lateral dislocation of the bones of the forearm is excessively rare: the only instance with which I am acquainted is a luxation outwards, reported by Nélaton, of which he has given a woodcut.

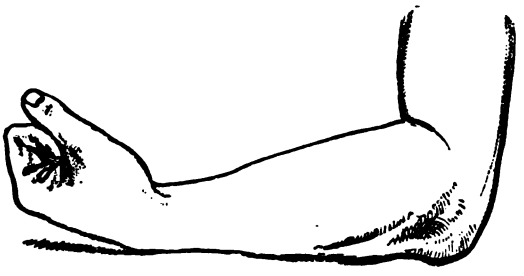
The ulna or radius alone may be displaced; and in some cases, both bones are dislocated, but in opposite directions, thus complicating considerably the nature of the accident.

2. *Ulna.*—The only dislocation to which the ulna alone is subject is that in a direction *backwards*. Although this displacement may occur in an uncomplicated form, it is more frequently associated with more or less dislocation of the head of the radius. When it occurs, it may be recognized by the projection of the olecranon backwards, and by the head of the radius being felt in its normal situation, or nearly so, during the movements of pronation and supination. In some cases the coronoid process is fractured at the same time, causing ready disappearance and recurrence of the dislocation, with crepitus.

3. *Radius.*—The radius alone may be dislocated *forwards*, *backwards*, or *outwards*. The dislocation *forwards* is certainly the most common. In the many instances of it that I have seen, it has resulted from a fall on the palm of the hand, by which the lower end of the radius being driven backwards, the upper end is tilted forwards with the whole force of the leverage of the bone, and in this way, rupturing the annular ligament, is thrown against the external condyle. The signs of this displacement are the following. The forearm is slightly flexed, and in a mid state between pronation and supination; any attempt at the latter position occasions great pain, as does also the endeavor to straighten the arm. The elbow can only be bent at an obtuse angle, in consequence of the head of the radius resting against the lower end of the humerus (Figs. 150, 152). On rotating the radius much pain

is experienced, and the head of the bone can be felt to roll on the fore part of the humerus, the external condyles of which project unnaturally. The hand and arm can be fully pronated, but cannot be supinated more than half way. The whole of the outer side of the arm is deformed, being carried somewhat upwards (Fig. 151). The rupture of the annular ligament in this dislocation makes it very difficult to keep the head of the radius properly fixed, so as to prevent a recurrence of the displacement.

Fig. 150.



Dislocation of the radius forwards: limit of power of bending the arm.

In some cases, and indeed not unfrequently, there is *incomplete dislocation of the radius forwards*, arising either from falls upon the hand, or from violent twists of

Fig. 151.

Dislocation of the radius forwards: deformity of outer side of the arm when extended.

the forearm. In these we have the preceding signs, though to a less marked degree. The most characteristic symptom, however, is the inability on the part of the patient

Fig. 152.

Position of the bones in an old unreduced dislocation of the radius forwards.

to flex the forearm upon the arm. This he can never do to a greater extent than to bring the elbow to a right angle (Fig. 150). On being told to touch the tip of his shoulder with his forefinger, he will find it impossible to do so.

The dislocation of the radius *backwards* is of extremely rare occurrence; it may always be recognized by the head of that bone being felt subcutaneously behind the external condyle; the movements of the elbow, and of the radius especially, being at the same time very limited and painful.

Dislocation of the radius *outwards* is of more frequent occurrence than the last injury, the head of the bone being thrown on the outer side of the external condyle, where it is felt under the skin, rolling as the hand is moved. The natural motions of the joint are of course greatly interfered with.

The radius and ulna are sometimes displaced in *opposite directions*, the ulna being thrown *backwards*, and the radius *forwards*. This injury, of which I have seen two instances at the hospital, usually results from heavy falls upon the hand, with a wrench of the limb at the same time, as when a person is thrown out of a carriage, or lights upon his hands, in consequence of which the bones are twisted and displaced in opposite directions. The deformity is of course great, but is readily recognized by the combination of the characters of the two forms of displacement, provided an examination be made before the swelling has come on, which rapidly sets in.

Complications.—Dislocations of the elbow-joint are very frequently complicated

with fracture of one or other condyle of the humerus, of the olecranon, and, as we have already seen in displacement of the ulna, of the coronoid process. In these complicated injuries an exact diagnosis is often extremely difficult, owing to the looseness and mobility of the parts, and to the great tumefaction that accompanies accidents of this description. It is in these cases that a good knowledge of the relative bearing of the different osseous points, aided by a comparative examination of the opposite limb, will alone enable the surgeon to effect a proper diagnosis of the nature of the injury.

The mode of *reduction* in dislocations of the elbow-joint varies according as the ulna is displaced or not. When the ulna is dislocated, in whatever direction it may be thrown, and whether the radius be displaced at the same time or not, we shall find that the great obstacle to reduction is the hitching of the processes of the bone against the articular end of the humerus. If either the olecranon or coronoid process be fractured, this entanglement cannot take place, and the joint then slips into its position without difficulty, though it is very difficult to maintain it there. The reduction of the displaced ulna, when uncomplicated by fracture, may always be effected, as Sir A. Cooper has recommended, by bending the arm over the knee. The patient being seated on a chair, the surgeon rests one foot upon the seat, and, placing the knee in the bend of the injured elbow, grasps the forearm with both hands (Fig. 153); fixing the arm, he presses the knee firmly against the inner aspect of the forearm, so as to disengage the ulna from the lower end of the humerus, and at the same time he bends or pushes the forearm into proper position, into which, indeed, it has a tendency to return by the action of its own muscles, so soon as the opposing osseous surfaces are separated.

Fig. 153.

Dislocation of the ulna: Reduction.

In dislocations of the radius, this movement across the knee is not necessary. All that is required is to fix the upper arm, and then, employing extension from the wrist, to straighten the arm well; when, by bending the elbow at right angles, the head of the radius may be pressed into a proper position.

After reduction has been effected, the limb should be firmly put up in lateral angular splints, the hand being kept semiprone. If the radius have been displaced, a pad should be applied over its head, so as to prevent a return of the displacement, which is very apt to occur when the orbicular ligament is torn. In the case of dislocation of the radius *forwards*, however, reduction is best maintained by placing the arm in the extended position, and applying a straight splint, well padded, along the palmar aspect of the limb. The inflammation which usually results must be combated by the free applications of leeches and of evaporating lotions. When this has subsided, passive motion may be commenced, and frictions and douches employed, so as to remove the stiffness that is apt to be left about the joint.

In those cases in which the dislocation is complicated with fracture of some part of the articular ends, and in which the diagnosis of the precise nature of the injury, owing to the swelling or other causes, has not been very clearly made out, the joint should be placed in as good a position as possible, by a process of traction, flexion, and moulding, so as to bring the osseous points into proper bearing with one another; the angular splints must then be applied, and local antiphlogistic treatment employed. At the end of a month or five weeks passive motion may be commenced, lest permanent rigidity come on, which is very apt to supervene.

Compound dislocations of the elbow are always very serious injuries. In their treatment, the surgeon will usually have to decide between resection of the articular ends of the displaced bones and amputation of the arm. He will be guided in the course he takes by the amount of mischief done to the soft parts. If these be simply lacerated over the posterior aspect of the joint—the dislocation, when com-

pound, being almost invariably backwards—the wound may be enlarged, and the articular ends removed. Should the soft structures be extensively contused and torn, the brachial artery or the median nerve injured, and the bones fractured as well as dislocated, amputation will be the safer course. In determining on the line of practice, however, the surgeon will be guided by the considerations stated at p. 264, in reference to compound fracture of this joint.

Old-standing dislocations of the elbow are reduced with much difficulty in all cases in which the ulna is completely displaced; this is owing rather to the interlocking of the irregular articular surfaces and to the formation of adhesions in the torn capsule and around the displaced bones, than to muscular contraction. The tendon of the triceps, and even that of the biceps, have been divided in some of these cases of old-standing dislocation of the elbow, in order to facilitate reduction. This operation, however, is seldom attended by any useful result, the difficulty of reduction not being dependent on the action of these muscles. In those instances in which I have done this operation or seen it adopted, but little, if any, good has resulted; and I have known troublesome sloughing to ensue. As a general rule, I believe that it will be found extremely difficult, even under chloroform and with the aid of the pulleys, to reduce an ulna that has been completely dislocated for more than a month. When the ulna is only partially dislocated, even though the radius be completely displaced, reduction may be effected without much difficulty at a very much later period—it is said, as late as two years after the accident; but here the difficulty is not to effect but to maintain the reduction and keep the bone in position, as it has a constant tendency to slip forwards and outwards. Provided a dislocated elbow can be so far reduced as to admit of the forearm being bent at a right angle, an useful arm will be left.

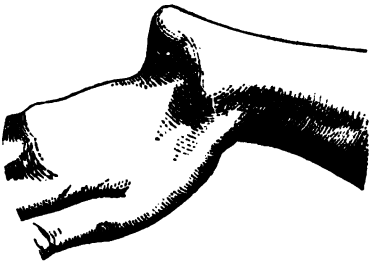
Dislocations of the Wrist are of rare occurrence; so much so, that their existence has been denied by Dupuytren and other modern surgeons of great experience. Although there can be no doubt that fractures of the lower end of the radius, more especially of an impacted character, have often been mistaken for these displacements, yet there can be now no question that they do occasionally, though rarely, occur. Any doubt that may formerly have existed upon this point, in consequence of the want of *post-mortem* examinations, has been in recent years cleared up by the dissections of cases that have been made by Marjolin and Voillemier. The observations of these surgeons, together with those previously made by Sir A. Cooper, tend to show that dislocation of the *hand and carpus* from the bones of the forearm may take place either *backwards* or *forwards*. In these dislocations, the displacement takes place between the carpus and the radius.

These accidents are occasioned either by falls on the palm, or by the hand being forcibly bent forwards. In falls on the palm, the hand may be thrown forwards under the bones of the forearm, lying on their palmar aspect. In forcible bending of the hand forwards, there will be a tendency to displacement of it and the carpus backwards on the dorsal aspect of the radius and ulna.

In the *dislocation of the hand and carpus backwards*—the *dorsal* displacement—there will be shortening of the length of the limb below the elbow, with a large dorsal prominence occasioned by the carpus overlapping the lower end of the radius, which bone will be felt and seen as a projection on the palmar side.

In the other variety of radio-carpal dislocation, the *hand and carpus are thrown forwards* under the radius and ulna on their *palmar* aspect. This dislocation is illustrated in the accompanying figure taken from a cast sent to me by my friend Mr. Cadge (Fig. 154). In it the projection of the styloid process of the ulna and the lower end of the radius form a concave line on the dorsal aspect, overlapping the carpus, which lies in front or on the palmar side of the radius.

Fig. 154.



Dislocation of the hand and carpus forwards.

The *diagnosis* of these injuries has to be made from sprains of the wrist, and from simple and from impacted fractures of the radius. From sprains of the wrist, the great and prominent deformity will at once enable the surgeon to distinguish a dislocation. From simple fracture of the lower end of the radius, the peculiar de-

formity, and the absence of crepitus, will afford ready means of diagnosis. It is from the impacted fracture of the lower epiphysis of the radius that it is most difficult to distinguish a dislocation. In the dislocation, however, the general laxity of the wrist-joint, the greater readiness with which the deformity is removed, the peculiar and abrupt swelling, and the absence of obliquity of the hand towards the radial side, will enable the surgeon to distinguish the true nature of the injury.

The *treatment* of these cases is simple, and in accordance with general principles. Reduction, which is readily effected, must be maintained by the application of antero-posterior splints of sufficient length to take in the hand.

Compound dislocation of the wrist, without fracture of the bones of the forearm, is an accident of rare occurrence. In one such case which came under my care at the hospital in consequence of injury inflicted on the arm by machinery, the hand was thrown forwards, the radius projecting backwards, and the soft structures on the palmar aspect of the joint were so extensively torn through as to necessitate amputation. The *treatment* of such a case will depend on the amount of injury done to the soft parts. If these be not very extensively injured, an attempt may be made to save the limb; but if they be widely torn through, the arteries and nerves lacerated, and the tendons perhaps hanging out, amputation will be required; this occurred, and the operation was performed, in the case to which I have just referred. This will be rendered more imperative if the bones of the forearm be comminuted as well.

Congenital dislocation of the wrist may take place either forwards or backwards. The limb is in either case greatly deformed. The bones are shortened and altered in shape, more especially the lower end of the radius. The muscles are also shortened, the extensor tendons forming a sharp angle as they pass over the carpus.

Dislocations of Single Bones of the Carpus are by no means of frequent occurrence. The bone that is most commonly displaced is the *os magnum*. This accident usually happens from falls, in which the hand is violently bent forwards, in consequence of which this bone starts out from its articulation, projecting as a round hard tumor on the back of the wrist opposite to the metacarpal bone of the middle finger. It may be readily reduced by being pressed upon at the same time that the hand is extended, thus pushing it into proper position. There is, however, a great tendency for this bone to slip out again, leaving considerable weakness of the joint; so much so, that, in two cases recorded by Sir A. Cooper, the patients found it necessary to wear artificial supports.

The *pisiform bone* is occasionally dislocated upwards. In a case under my care, it was displaced by an effort to lift a heavy weight, and drawn up the arm to a distance of nearly an inch by the flexor carpi ulnaris.

A case some time ago occurred to me, at the hospital, in which the *semilunar bone* was dislocated. The patient in whom this accident happened, had fallen from a height, injuring his spine, and doubling his right hand under him. On examining the wrist, a small hard tumor was felt projecting on its dorsal aspect; it readily disappeared on extending the hand and employing firm pressure, but started up again so soon as the wrist was forcibly fixed. It was evident that this bone belonged to the first row of the carpus, articulating with the radius; and from its size, its position towards the radial side of the carpus, and its shape, which could be very distinctly made out through the integuments, there could be little doubt that it was the semilunar bone.

Dislocations of the Metacarpal Bones.—Besides the above-mentioned dislocations, the *metacarpal bones* may possibly, though far more rarely, be dislocated from the carpus. This accident usually happens to a single metacarpal bone; which, in consequence of some extreme degree of violence, is forced out of its bed and is thrown backwards on the carpus. Most frequently this accident is the result of injury and shattering of the hand by gun-barrel or powder-flask explosions; and in such cases the metacarpal bone of the *thumb* is the one that commonly suffers, the dislocation also usually being compound, and complicated with fracture of the bones and extensive palmar laceration. Dislocation of the thumb, however, is rare, though the articulation between this bone and the trapezium appears at first not to be of a character to resist much external violence. This is probably owing in a great measure to the powerful muscles by which the bone is supported in all cases in which the force is applied upon its palmar aspect, as it most frequently is, as well

as to the little leverage offered by so short a bone. Luxation, however, of the metacarpal bone of the thumb has been observed to take place *forwards* as well as *backwards*, the latter being the most common. The *reduction* is in general easy, extension being made from the thumb by means of a piece of tape applied round the first phalanx.

Fig. 155.

Dislocation of the metacarpal from the carpal bones.

Next to the metacarpal bone of the thumb, those of the *index* and *middle fingers* are most liable to dislocation backwards; sometimes complete, at others incomplete.

I am not acquainted with any case on record in which *all* the metacarpal bones have been dislocated from the carpus. The annexed engraving (Fig. 155) is from a cast in University College Museum, taken from a patient in the hospital, in whom I believe that this accident must have occurred; the hand being thrown forwards, and the carpal bones forming a rounded and *convex* prominence on the dorsum. The convex appearance of this corresponds with the outline of the carpal bones, and differs so very remarkably from the concave aspect of the lower end of the radius and ulna, as seen in the radio-carpal dislocation (Fig. 154), that I think there can be little doubt as to the nature of the injury sustained by the patient.

The *treatment* of such cases will be the same as that for ordinary dislocations of the carpal bones; splints of sufficient length to take in the hand being applied, after reduction, in order to maintain the parts in position.

Dislocations of the Metacarpo-Phalangeal Articulations are by no means of common occurrence, though occasionally met with. Most frequently the *proximal phalanx of the thumb* is the bone that is dislocated, being thrown *backward* on the metacarpal bone (Fig. 156) in such a way that the articular surface of the phalanx rests upon the back of the metacarpal bone immediately below its head. The signs of the accident are sufficiently evident. In the normal state of the hand, the metacarpo-phalangeal articulation of the thumb is convex backwards. In this dislocation it becomes convex towards the palmar aspect and angularly concave behind. The head of the metacarpal bone can be felt and seen projecting on the palmar aspect of the thumb. The proximal phalanx stands up as it were upon the back of this bone, but the articular surface of the phalanx cannot be felt, owing to its standing up, as it were, on this. The phalangeal articulation is always semi-flexed. This dislocation of the proximal phalanx of the thumb has, owing to the difficulty of its reduction, attracted more attention than it would at first appear to deserve. So great has this difficulty been in some cases, as to render the dislocation irreducible, or to compel the surgeon to have recourse to operative interference in order to replace the head of the bone. The obstacle to the ready reduction of this small bone has been attributed to different causes. Thus, Hey supposed that it was owing to the constriction of the neck of the bone between the lateral ligaments of the joint; and Dupuytren entertained a very similar opinion, looking upon the position of these ligaments as the principal source of difficulty. The folding of the anterior ligament of the joint, and the interposition of a sesamoid bone between the articulating surfaces, have also been looked upon as giving rise to this peculiarity.

Fig. 156.

Dislocation backwards of the proximal phalanx of the thumb.

The more probable explanation, however, appears to be that the narrow neck of the metacarpal bone becomes locked between or constricted by the two terminal attachments of the short flexor of the thumb, which must be carried back over its broader head, together with the displaced phalanx. The observations of Vidal, Malgaigne, and Ballingall point to this as the cause of the great difficulty in reduction that is often met with. This difficulty, however, does not always exist, for in many cases this dislocation may be *reduced* readily enough by the surgeon making extension with his fingers simply, and then pushing the bone into place, or, better still, after making some traction, by forcibly bending the phalanx towards the palm

of the hand. If these means do not suffice, the hand should be fixed, and steady traction then be made from the phalanx, to which, previously protected by a strip of wet wash-leather, a piece of tape has been applied with a clove-hitch knot; or, if more force be required, the pulleys may be used. In some cases the bone may be replaced by passing the ring of a door-key over the thumb, fixing one side against the projecting head of the phalanx, and then drawing and pressing this into its proper position. If all these means fail, subcutaneous section of the opposing muscle may be practised. I have reduced a dislocation of this joint, between five and six weeks after its occurrence by traction and manipulation. If the dislocation be left unreduced, Sir A. Cooper says that the patient may still have a very useful thumb.

[Fig. 157.

Dislocation of the first phalanx of the thumb backwards.]

[Fig. 158.

Crosby's mode of reduction.]

[Dr. Crosby has described a method of reducing this dislocation which has in his hands proved very effective. The displaced thumb is to be pressed upwards and backwards until it forms a right angle with its metacarpal bone; then by pressing forwards the base of the phalanx, the thumb may be flexed, and the dislocation will be found to have been reduced.—A.]

In *compound dislocation* of this joint the bone may usually readily be replaced; should there be any difficulty its head must be removed, the dislocation being then reduced with great readiness, and the wound treated in a simple manner. When this dislocation is compound, with much laceration of the integuments, disorganization and destruction of the joint usually ensue, demanding removal of the end of the thumb.

Dislocations of the Phalanges rarely occur. These dislocations are partial or incomplete, and usually consist of a twist of the second upon the proximal phalanx. I do not think that simple dislocation of the ungual phalanx from the second is a possible accident. The dislocation of the middle phalanx is readily recognized by the deformity it entails (Fig. 159), and is easily reduced by pressure and traction in proper directions, but the finger will continue to be stiff and comparatively useless for some length of time. The joint being swollen and tender, the patient can generally bend it, but cannot extend it fully or bear any traction upon it. This condition is especially apt to be troublesome and chronic if the patient be gouty, or if his general health be otherwise deranged, and requires rest and local counter-irritation, with an anti-gouty treatment, for its remedy. In *compound dislocation* of the phalanges, the bone should be replaced, the finger supported by a gutta-percha splint, and the wound dressed lightly. In some cases it is necessary to remove the projecting end of bone before this can conveniently be done: anchylosis then results, a sufficiently useful finger being left.

Fig. 159.

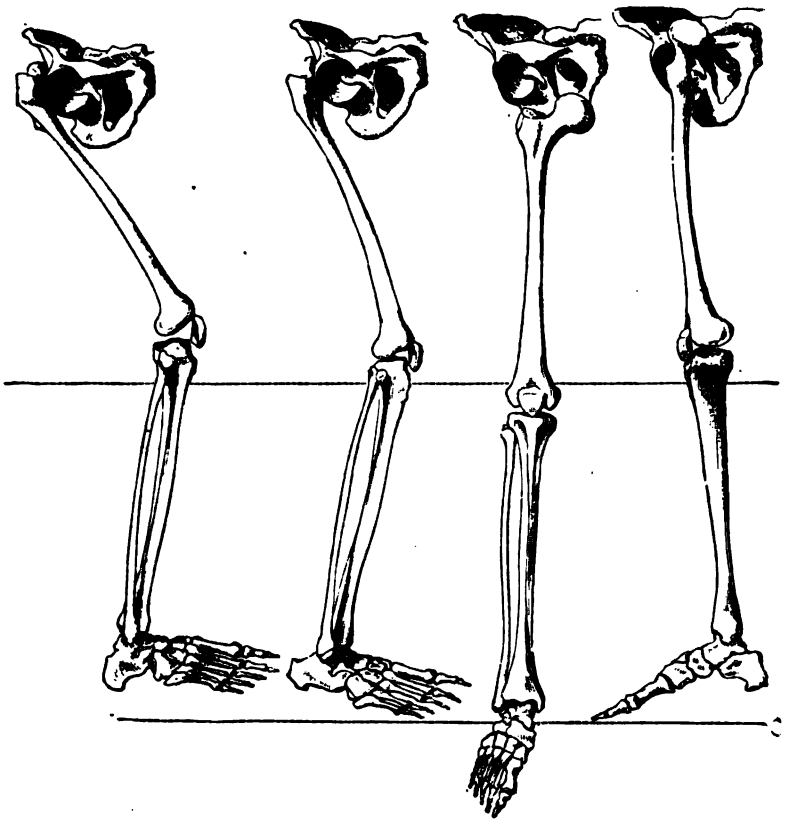
Dislocation of the middle finger.

Dislocations of the Pelvis.—It often happens that, in consequence of severe blows upon or compression of the pelvis, the *symphysis of the pubic bones*, or more frequently the *sacro-iliac articulation*, is displaced. Here the nature of the injury is indicated by the deformity that results; and the same treatment is required as in fracture of the pelvis, with which these accidents are commonly associated.

The *coccyx* is sometimes violently bent and almost dislocated *forwards* by falls; or it may be forcibly bent *backwards* during violent parturient efforts. These accidents may be remedied by manipulation through the rectum; but are apt to be followed by that painful neuralgic affection *coccydynia*, described at p. 271.

Dislocations of the Hip.—Notwithstanding the great depth of the acetabulum, the complete manner in which the head of the thigh-bone is received into its cavity, the firmness of the capsular ligament, and the great strength of the capsular muscles that surround and support the joint, dislocations of the hip are more frequently met with than those of many other joints that appear less perfectly supported. This is

Fig. 160. Fig. 161. Fig. 162. Fig. 163.



DISLOCATIONS OF THE HEAD OF THE THIGH-BONE.

Upwards and somewhat backwards, on dorsum ilii.	Backwards into sciatic notch.	Downwards into foramen ovale.	Forwards and upwards on the pubic bone.

doubtless in a great measure owing to the action, on the head of the femur, of the great length of leverage, of the thigh-bone itself when external violence is applied to the knee, and of the whole of the lower extremity when the violence is applied to the foot.

The different forms of dislocation of the femur have been described with great clearness and precision by Sir A. Cooper, who has shown that its head is most commonly thrown *upwards and somewhat backwards*, so as to lodge on the slightly concave surface between the acetabulum and the crista ilii, resting on the gluteus minimus, and having the trochanter turned forwards (Fig. 160); or it may be thrown *downwards* into the foramen ovale, lying upon the obturator externus muscle (Fig. 162); or *forwards and upwards* upon the horizontal branch of the pubic bone under the psoas and iliac muscles, to the outer side of the femoral vessels (Fig. 163); the head of the bone may also be thrown *backwards* into the sacro-sciatic notch, resting upon the pyriformis muscle (Fig. 161). These are the four forms of the dislocation of the hip admitted by Sir A. Cooper as of the more usual character; besides these, however, may be added, as not of very unfrequent occurrence, that form in which the bone is thrown *backwards and somewhat downwards* behind the tuberosity of the ischium. In addition to these, other less common forms of dislocation have been

noticed; for instance, one in which the head of the bone lies between the anterior superior and the anterior inferior spinous processes of the ilium, or that in which it has been thrown upon the spine of the ischium.

The extent of mischief done in the soft parts around the joint varies in different dislocations. In all, the capsular ligament is torn in a greater or less extent, and in the direction of the displacement; and in most, the ligamentum teres is ruptured. But Dupuytren and Sedillot both mention cases of dislocation on the dorsum ilii in which this ligament escaped without rupture. In the dislocation on the dorsum ilii, Sir A. Cooper has found the gemelli, obturatores, and quadratus completely torn across, and the pectineus slightly torn. In the dislocation into the sciatic notch, Billard d'Angers has found the gluteus maximus and medius torn, and the gemelli ruptured. Syme found the gluteus maximus extensively torn, with the head of the bone imbedded in it; the gluteus minimus, the pyriformis, and the gemellus superior lacerated; and the head of the femur lying upon the gemelli and the great sciatic nerve. In the displacement on the obturator foramen, the pectineus and abductor brevis are torn. In the dislocation on the pubic bone, the extent of injury is more uncertain. In one case related by Sir A. Cooper, Poupart's ligament was torn up, and in another the pectineus and adductors were torn; but whether this was done by the dislocation or by the direct injury that occasioned it, is uncertain.

The signs, causes, and treatment of the different dislocations of the hip differ so greatly from one another that, practically, it becomes necessary to describe each of these displacements as a separate lesion. In considering these, we may reduce the more ordinary dislocations of the hip to three distinct varieties; bearing in mind the other and less usual forms of displacement which may occur. With regard to their relative frequency, Sir A. Cooper says, that of 20 cases of dislocation of the hip, 12 will be on the dorsum ilii, 5 on the sciatic notch, 2 on the obturator foramen, and one on the pubic bone. Hamilton states that, excluding anomalous cases, of 104 cases of dislocation of the hip, which he has collected, 55 were on the dorsum ilii, 28 into the sciatic notch, 13 into the obturator foramen, and 8 upon the pubic bone.

Dislocation of the hip-joint chiefly occurs in young or middle-aged adults. In very old people, fracture of the neck of the femur will commonly occur from the same violence that would have displaced the head of the bone at an earlier age. In children dislocation is rare, as the shaft will generally give way. Yet it does happen even at a very early age. Two cases have occurred in my practice at the hospital. In one the bone was dislocated on the pubic, in a child a year and a half old; in the other on the dorsum ilii in a boy of six.

1. The most common dislocation, then, is that in which the head of the bone is thrown *upwards and backwards* upon the dorsum of the ilium, or rather upon that portion of the bone which extends between the acetabulum and the sacro-sciatic notch (Fig. 160). This displacement differs so slightly in its pathology and treatment from the dislocation into the sciatic notch (Fig. 161), described as a distinct variety of the injury by Sir A. Cooper, that I think it is more consistent with the true nature of these accidents to look upon them as essentially the same; the displacement in both cases being upwards and backwards, but in different instances partaking more of one or other direction. This dislocation may therefore be described as the *ilio-sciatic*.

2. The next distinct dislocation is that in which the head of the bone is thrown *downwards* upon the obturator foramen, hence termed the *thyroid* dislocation (Fig. 162).

3. The third variety is the *pubic*, where the head of the bone is thrown *upwards* upon the pubic bone (Fig. 163); and lastly,

4. Various "anomalous" forms of dislocation may occur in different directions; as upwards, downwards, backwards, and forwards.

Thus it will be seen that, in whatever direction the displacement occurs, the head of the bone has a tendency to sink into some cavity or depression, or to lie upon one of the osseous surfaces in the neighborhood of the acetabulum.

1. *Dislocation Upwards and Backwards*, or *Ilio-sciatic*.—In this, if the head of the bone rest upon the *dorsum of the ilium*, the hip will be found to be a good deal distorted, the gluteal region being somewhat prominent, and the upper part of the thigh enlarged, in consequence of the approximation of the muscular attachments, so as to give an appearance of widening to the hip. The head of the bone can be

felt in its new situation, more especially on rotating the limb; the trochanter is less prominent than natural, usually lying close against the brim of the acetabulum, and being turned forwards; there is marked shortening, varying from one to two inches in some cases, perhaps even as much as three inches. The amount of shortening will necessarily depend upon the distance to which the head of the bone is thrown *upwards* on the dorsum. The position of the limb is remarkable, being distinctly rotated inwards, with the thigh slightly bent upon the abdomen, and the leg upon the thigh, so that the knee is semi-flexed, and raised from the surface on which the patient is lying. The foot is inverted, so that the ball of the great toe rests on the instep or against the ankle of the sound limb; and the heel is somewhat raised. The axis of the dislocated thigh is directed across the lower third of the sound thigh (Fig. 160). The movements of the joint are greatly impaired; abduction and eversion are not practicable; but inversion, abduction, and some flexion upon the abdomen, can be practised. When the patient is lying flat, with the knee slightly raised and advanced, the lumbar spine is on its proper level; but if an attempt be made to straighten the knee, so that the limb lies flat, the lumbar spine will arch forwards.

When the head of the bone slips a little further back so as to become lodged in the *sciatic notch*, we have the dislocation "backwards" of Sir A. Cooper. In this the same symptoms exist, though to a less degree; hence the diagnosis is proportionately difficult (Fig. 161). There is much less deformity about the hip in this variety of the displacement, owing to the head of the bone sinking into the hollow of the notch, and thus presenting the trochanter nearly in its usual position at right angles with the ilium, though somewhat behind and a little above its normal situation. In consequence of the head of the bone being received in a depression, the axis of the limb is not altered to the same extent as when it is thrown upon the plane surface of the dorsum ilii; hence the inversion of the knee and foot, though existing, is not so strongly marked. As the sciatic notch is but a little above the level of the acetabulum, the shortening of the limb is inconsiderable, not exceeding half an inch or an inch at most. The axis of the limb also is directed across the sound knee. Thus the signs of these two forms of dislocation are nearly identical in character, though varying in degree; the principal difference being that, when the head of the bone rests in the sciatic notch, the axis of the femur is directed to the opposite knee, whereas, when the head of the bone is lodged on the dorsum ilii, the axis of the limb is directed across the lower part of the sound thigh.

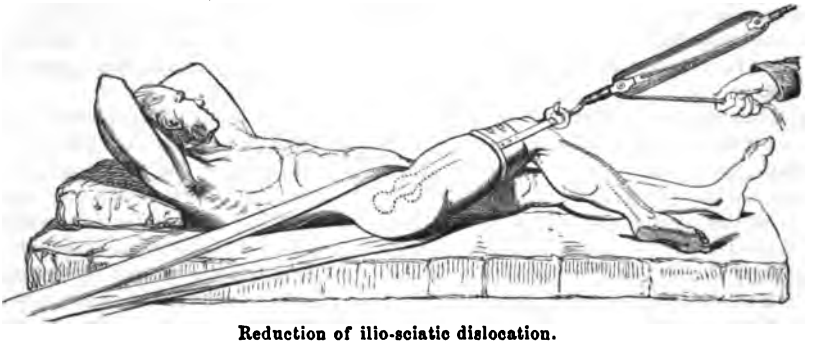
Causes.—The dislocation upwards and backwards is that which is most frequently met with in the hip. It is occasioned by violence acting upon the limb whilst abducted, with the body bent forwards upon the thigh, or the thigh upon the abdomen; as when a person is struck on the back with a heavy weight, or is thrown forwards, or falls whilst carrying a heavy load upon his shoulders, when the upper and posterior part of the joint receives the whole of the strain. In these circumstances, the capsular ligament is ruptured, and the bone slips out of its articulation.

The *diagnosis* of this form of dislocation is easy in proportion as the head of the bone lies high on the dorsum ilii. The more it sinks towards and into the sciatic notch, the more difficult does the detection of the displacement become, and the greater the risk of its being overlooked altogether, or mistaken for a sprain. In ordinary cases of fracture of the neck of the thigh-bone, the existence of eversion of the limb at once points out that the head of the bone is not dislocated on the ilium. The only severe injury of the hip with which the dislocation upwards and backwards can be confounded, are those rare cases in which there is *fracture of the neck of the thigh-bone, with inversion of the limb.* In such instances, the increased mobility, and the existence of crepitus, will enable the surgeon to effect the diagnosis. Should, however, the fracture be an impacted extracapsular one, with inversion, then the difficulty of diagnosis is undoubtedly great. A correct conclusion may, however, be arrived at, by observing that in the fracture the flattened trochanter is approximated to, and in nearly a perpendicular line with, the anterior superior spine of the ilium; whilst in the dislocation the trochanter is diagonally behind that process of bone, and the head of the thigh-bone can be felt in its new situation by deep manipulation of the gluteal region.

The *reduction* of this form of dislocation is effected in the following manner. The patient, having been put under the influence of chloroform, is laid on his back upon a strong table between two staples, one of which should be fixed to the floor

and another at a point above the level of the body, in a direct line with the axis of the limb, and about twelve feet apart. The counter-extending force, consisting of a jack-towel or a padded leather belt, must then be passed between the injured thigh and the perineum, and fixed to the staple in the floor. The pulleys must now be attached to proper straps, or to a towel fixed with a clove-hitch knot immediately above the knee, by one end; the other extremity being attached to the staple in the wall, which should be so situated as to be continuous with the axis of the lower part of the limb. The knee being then slightly bent and rotated inwards, traction is applied slowly and steadily until the head of the bone has approached the acetabulum, when the surgeon rotates the limb inwards so that the head may slip into its socket (Fig. 164). If difficulty occur in raising the bone over the acetabulum,

Fig. 164.



Reduction of ilio-sciatic dislocation.

recourse may be had to the plan recommended by Sir A. Cooper, of passing a towel under the thigh to enable an assistant to lift the head of the bone over the brim of that cavity. The fact of the reduction being accomplished is ascertained by comparing the bony points of the limb with those of the opposite side, and seeing if they correspond. A long splint and spica bandage should now be applied to fix the thigh, and the patient should be kept in bed for a fortnight, so that reunion of the ruptured tissues may take place. In reducing this dislocation, there is some danger of the head of the bone slipping downwards into the sciatic notch, if the limb be too much raised. This accident, which has happened to some very excellent surgeons, may be mistaken for reduction of the bone; a serious mistake, which would, unless corrected, entail permanent lameness on the patient.

When the bone is thrown upon the sciatic notch, the reduction is difficult, and a slight modification of the treatment is required; this consists in laying the patient on his sound side instead of on his back, and making extension across the middle of the sound thigh instead of immediately above his knee, as in the last case. In the reduction of this dislocation also, Sir A. Cooper gives the very valuable advice, to lift the head of the bone out of the notch and over the edge of the acetabulum by means of a round towel placed under the upper part of the thigh and over the shoulders of an assistant, who, first stooping and at the same time resting his feet on the patient's pelvis, should then raise his head and draw the bone towards its socket.

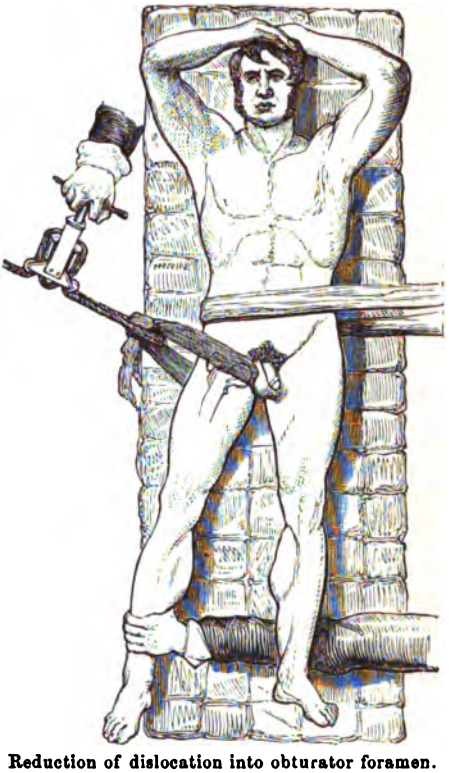
Reduction of dislocation on the dorsum ilii or sciatic notch may be effected readily enough whilst the patient is under the influence of chloroform, by "manipulation" of the limb, as introduced by Dr. Reid, of Rochester, U. S. This is done by flexing the leg on the thigh, and carrying the dislocated thigh over the sound one, flexing it slowly upwards, across the pelvis, as high as the umbilicus, and then abducting and rotating it outwards.

2. *Dislocation Downwards into the Obturator Foramen.*—Here we find the hip flattened, and the prominence of the trochanter completely absent, or indeed replaced by a depression. The limb is lengthened by about two inches, advanced before the other, and considerably abducted (Fig. 162). The knee is bent and incapable of extension; the foot usually points forwards, but is sometimes slightly everted, and is widely separated from its fellow. The body is bent forwards in consequence of the tension of the psoas and iliac muscles, and in thin persons the bone may be felt in its new situation.

Causes.—This dislocation appears to be occasioned by the limb being suddenly and violently abducted, as by falls with the legs widely separated; in consequence of which the head of the bone is tilted against the inner side of the capsule, and, rupturing this, is thrown into the thyroid notch.

In the *reduction* of this dislocation the patient should be placed upon his back; the counter-extending girth, or towel, is then placed round the pelvis, and fixed firmly to a staple next to the sound side of the patient. A padded girth is then to be placed between the perineum and the upper part of the dislocated thigh. From this, extension is made by means of the tourniquet or the pulleys, which are fixed to a staple at a little distance from the injured side of the patient. Extension having then been made to such a degree as to elevate the head of the bone from the depression in which it lies, the surgeon passes his hand behind the sound leg, and, seizing the ankle of the injured limb, draws it backwards and towards the mesial line, taking care to keep the knee straight, and thus throwing the head of the bone into the acetabulum by the action of a long lever (Fig. 165).

Fig. 165.



Reduction of dislocation into obturator foramen.

[Reduction of this and of the next form of dislocation may usually be satisfactorily effected by manipulation; the process must be exactly the reverse of that employed by Dr. Nathan Smith, Dr. Reid, and others for dislocation on the dorsum ilii. The leg being flexed on the thigh, the latter is *abducted* and flexed upon the belly; then being *adducted* and rotated inwards, the head of the bone will usually slip at once into the actebalum, upon the limb being brought down. If the thigh in this manipulation be too much *adducted*, the dislocation may be changed into the upward and backward variety, just as too great *abduction* in the process for reducing the latter may convert it into a dislocation into the obturator foramen.—A.]

3. *Dislocation Upwards on the Pubic Bone* (Fig. 163).—This presents very unequivocal signs. The hip is flattened; the head of the bone can be distinctly felt lying in its new situation above Poupart's ligament, to the outer side of the femoral vessels, where it may be made to roll by rotating the limb. The thigh and knee are slightly flexed, rotated outwards, and abducted; the limb, which is separated from its fellow, is shortened to the extent of an inch.

The *cause* of this dislocation is either direct violence applied to the back of the thigh whilst the limb is abducted; or it arises from the patient making a false step in walking, and, suddenly throwing his body backwards in order to avoid a fall, twisting and displacing the limb.

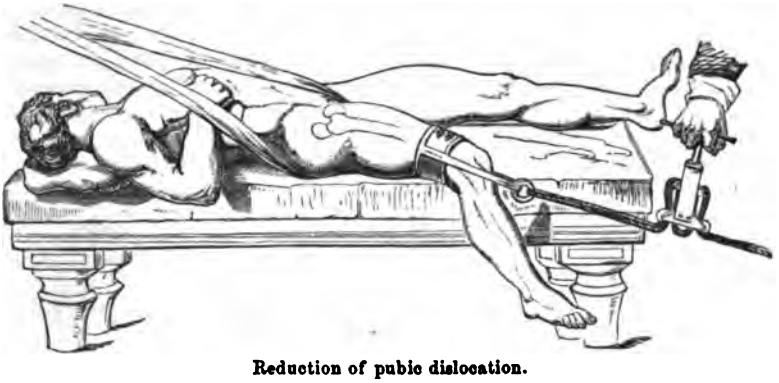
With regard to the *treatment*, Sir Astley Cooper advises that the patient should lie upon his back with his legs widely separated; and that, counter-extension being then made by a girth carried between the perineum and the injured thigh, and fixed to a staple in front of and above the body, the pulleys should be fixed upon the lower part of the thigh, and the extension made downwards and backwards. After this has been continued for a sufficient time, an assistant lifts the head of the bone by means of a towel over the brim of the acetabulum (Fig. 166).

4. *Other forms of Dislocation of the Hip.*—The head of the thigh-bone may be dislocated in a variety of other directions.

a. It may be thrown *directly upwards*, so as to be situated under the anterior inferior spinous process, or between it and the anterior superior, with considerable

shortening of the limb and the head of the bone to be felt in a new situation. In a case related by Cummins, the limb was shortened three inches.

Fig. 166.



Reduction of pubic dislocation.

β. The head of the bone may be thrown *directly downwards*, as happened in a case of Luke's, the head of the bone lying midway between the sciatic notch and the thyroid foramen, the gemellus inferior and the quadratus femoris having been torn.

γ. The head of the thigh-bone may be thrown *downwards and backwards*, lying upon the posterior part of the body of the ischium, between the tuberosity and the spine. It can be felt in this situation, and the limb is inverted.

δ. The head of the bone may be thrown *downwards and backwards* into the lesser sciatic notch. In these cases there is considerable shortening, but the position of the limb appears to vary. In an instance that occurred to Keate, the limb was abducted, and the toes turned outwards. In a case reported by Wormald the limb was turned inwards. Although the limb is described as shortened in these cases, Warren has related a case in which it was elongated.

ε. The head of the thigh-bone may be thrown *forwards and inwards* into the perineum, so as to rest on the ramus of the pubic bone. In these cases the head of the bone can be felt in its abnormal situation behind the scrotum; and, compressing the urethra, has given rise to retention of urine. In one case the toes were turned inwards, in another outwards; the thigh usually projects forwards.

It is extremely difficult to lay down any distinct rules for the reduction of these various anomalous forms of dislocation. This will, however, usually be effected by extension by means of the pulleys in the direction of the axis of the bone, and by manipulation and rotation of its head towards the acetabulum.

Reduction of old dislocations of the hip-joint is attended not only with great difficulty, but with no small amount of danger. The probability of effecting reduction rapidly decreases with the length of time that the bone has been left unreduced, and this more in some dislocations than in others. Thus, it is easier to reduce an old dislocation on the dorsum ilii than one into the ischiatic notch. Dislocations of the head of the thigh-bone on the dorsum of the ilium may usually be reduced without any great increase of difficulty, up to the end of the first fortnight. After that time the difficulty increases considerably; and, although reduction has frequently been effected in these cases up to the sixth or eighth week, yet it has also not unfrequently failed, notwithstanding persevering and repeated attempts. After two months have elapsed, the reduction is not only a work of great uncertainty, but also of no slight danger from abscess of the soft parts, or fracture of the femur; and it is then seldom practicable. But cases have been reported, and are referred to at p. 293, in which these dislocations have been reduced at a much later period, even after six months.

If the bone be left permanently unreduced, it will in time acquire considerable mobility, more particularly if lying in the ischiatic notch, the patient walking readily with a shortened but otherwise useful limb.

The attempt to reduce old dislocations of the hip-joint is necessarily attended with danger. In some cases the soft parts have been extensively lacerated; in

others fatal inflammation of the joint has ensued; and, in at least eight cases with which I am acquainted, the thigh-bone has been fractured. This accident has happened to surgeons of such eminence as Travers, Vincent, Malgaigne, Physick of Philadelphia, to Gwynne of the Brighton Hospital, to Blackman of Cincinnati, to Harris and Randolph of the Pennsylvania Hospital, to the surgeons of the Northern Hospital in Liverpool, and to a practitioner in London now living. In most of these cases the bone gave way at its neck or below the trochanters; the dislocation was of course left unreduced, but the patients recovered without serious difficulty, the fractures being treated in the usual way. The cause of the fracture usually appears to have been the employment of force in a transverse or rotatory manner after extension had been kept up for some considerable time. But there is no proof that undue violence was used in any of these cases.

[In several cases of old dislocation of the hip, where I have succeeded by manipulation in bringing the head of the bone directly over the acetabulum, the changes in that cavity have been so great as to prevent permanent reduction, the head of the femur slipping out again upon the slightest motion of the patient. Even if reduction cannot be effected, advantage is sometimes gained from the increased mobility resulting from the surgeon's manipulations.—A.]

The *complication of fracture of the femur with dislocation of the hip-joint* occasions a very serious state of things, that may baffle the most skilful efforts on the part of the surgeon to counteract. The line of practice to be adopted must depend in a great measure on the seat of fracture. If this be situated below the middle of the thigh, the limb should be put up tightly in temporary splints, and an attempt made under chloroform to reduce the dislocation in the ordinary way by pulleys applied over the splints, or by manipulation. If the fracture be high up, near or at the neck, the patient should be put under chloroform, and an attempt then made by pressure on the dislocated head and manipulation to replace it. It is possible that this might be effected, as in similar injuries of the humerus, with comparatively little trouble. Should reduction in this way not be practicable, we may adopt the plan successfully employed by Mr. Badley, who, in a lad of eighteen, with dislocation on the dorsum ilii, and fracture of the displaced bone, allowed union of the fracture to take place, and then at the end of five weeks effected reduction.

Simultaneous dislocation of both hips, perhaps in different directions, or of one hip with fracture of the opposite thigh-bone, has been met with in some rare instances.

Congenital dislocations of one or both hips is occasionally seen. In these cases the spine is bent forwards in the lumbar region (lordosis); the trochanter is approached to the anterior superior spine; the thigh seems shortened; and the head of the bone may be felt on the dorsum ilii. The patient walks well, with a peculiar rolling motion.

[Mr. Brodhurst has treated congenital dislocation of the hip successfully by subcutaneous myotomy and the use of a straight splint with extension (*St. George's Hosp. Reports*, vol. i. p. 219). If seen during the first two years of life a cure can usually be effected without the use of the knife.—A.]

Dislocations of the Patella are not frequently met with. They may, however, occur in four directions, viz., *outwards*, *inwards*, *edgewise* or *vertically*, and *upwards*.

1. The dislocation *outwards* is the most common variety of the accident; the bone being thrown upon the outer side of the external condyle of the femur, with its axis directed somewhat backwards and downwards. The knee is flattened in front, and is broader than usual; the patella can be felt in its new situation, and the muscles that form the quadriceps extensor are rendered tense, more especially the vastus internus; the leg is sometimes extended, but more frequently the knee is slightly flexed. This accident usually happens from sudden muscular contraction in persons who are knock-kneed. In some cases it has been occasioned by direct violence, driving the bone out of its position. Most frequently the dislocation is not quite complete, the patella being only partially displaced outwards, with some rotation of the bone in the same direction.

2. The dislocation *inwards* is of very rare occurrence; Malgaigne, who has investigated this subject, being of opinion that there is only one case of the kind on record.

In these lateral dislocations, *reduction* may be effected by laying the patient on his back, bending the thigh on the abdomen, and raising the leg so as to relax the extensor muscles. The surgeon then, by pressing down that edge of the patella

which is furthest from the middle of the joint, raises the other edge, which, being tilted over the condyles, is immediately drawn into position by the action of the extensors.

3. A remarkable form of dislocation of the patella is that in which this bone becomes twisted upon its axis in such a way that it is placed *vertically*, one of its edges being fixed between the condyles, and the other projecting under the skin, and pushing this forwards into a distinct tumor. In some cases, as those of Woolf and Mayo, the bone has been turned almost completely round, the posterior articular surface becoming partly anterior. The signs of this dislocation are evident, manual examination indicating the vertical displacement of the patella, with a deep depression on each side. The limb is completely extended, flexion being impossible.

This peculiar dislocation is of very rare occurrence, there being not more than ten or twelve cases on record. It has most generally arisen from sharp blows or severe falls upon one edge of the patella, whilst the limb has been semiflexed, in consequence of which the bone appears to have been semirotated and fixed in its new position. Violent muscular contraction, however, conjoined with a twist of the leg, but without any blow, has been known to occasion it in some cases.

The *reduction* of this displacement has sometimes been attended by the greatest difficulty; in other cases it has been readily effected; whilst in two or three instances it has been found to be quite impracticable; surgeons having ineffectually attempted, by means of elevators and the section of the tendons or of the ligamentum patellæ, to replace the bone, and the patient having eventually died from traumatic suppuration of the joint, with the displacement unrelieved. The cause of this difficulty of reduction is not very distinctly made out; it is certainly much greater than can be explained by simple muscular contraction, and may not improbably be owing to the resistance offered by the aponeurotic structures which cover the bone becoming twisted or entangled under it, or, as Malgaigne supposes, by the superior angle of the bone being wedged in the *subcondyloid* space. If relaxation of the muscles of the thigh, and the employment of proper pressure upon the patella, do not succeed, reduction may perhaps be effected by directing the patient to make a sudden and violent muscular effort at extension of the limb, or by attempting to walk. In other cases the bone has been readily replaced by bending the leg, and rotating it on the axis of the tibia, at the same time that the patella is pressed into position, as Vincent recommends. Upon the whole, forcible flexion of the knee appears to have answered better than any other method, and under chloroform will probably seldom be attended by difficulty. Should these plans not answer, I do not think it would be advisable to have recourse to subcutaneous section of the tendon of the quadriceps extensor and of the ligamentum patellæ. In one case in which both these structures were divided, the patella remained as firmly fixed as ever, and the patient eventually died of suppurative inflammation of the knee-joint; and in no case in which division has been practised does it appear to have facilitated the reduction of the bone.

4. Dislocation of the patella *upwards* can only occur as a consequence of the rupture of its ligament. This accident, which is always accompanied by much inflammation of the joint, requires the same treatment as a fractured patella.

Dislocations of the Knee.—This joint, owing to the breadth of its articular surfaces, and the great strength of its ligaments, is seldom dislocated. When such an accident happens, it usually arises from falls from a great height, or by the patient jumping from a carriage in motion. The tibia may be displaced in four directions: *to either side*, *forwards*, or *backwards*. Besides these displacements, the joint is subject to a partial luxation dependent upon displacement of the semilunar cartilages.

1. The *lateral* dislocations of the tibia are the most common. They are always *incomplete*, and are usually accompanied by a certain degree of rotation of the limb in an outward direction. These displacements may either be *external* or *internal*. In the first, the outer condyle of the femur rests upon the inner articular surface of the tibia. In the other, the inner condyle is placed upon the outer articular surface of the head of this bone. In either case, the knee is slightly flexed; there is a marked sulcus in the situation of the ligamentum patellæ; the extensor muscles of the thigh are relaxed, and the deformity of the joint indicates at once the nature of the displacement to which the bones are subjected.

In these cases *reduction* is always easy; indeed, occasionally it is effected by the unaided efforts of the patient or by a bystander. It may be accomplished by flexing

the thigh upon the abdomen, then extending the leg, and, at the same time, by a movement of rotation, replacing the bones in their proper position.

2. The dislocation *backwards* may be *complete* or *incomplete*. When it is complete, the posterior ligament of the joint is torn, the muscles of the ham are stretched, the limb is shortened to the extent of an inch and a half or two inches, and is semiflexed; the head of the tibia can be felt in the ham, and there is a deep transverse depression in front of the joint immediately below the patella.

3. The dislocation of the tibia *forwards* is of more frequent occurrence than the last accident. In it, the lower end of the femur is felt projecting into the ham, compressing the vessels to such an extent occasionally as to arrest the circulation through the lower extremity, lacerating the ligaments, and stretching the muscles in this situation. The tibia is felt to project forwards, its head forming a considerable prominence on the anterior part of the knee, with a deep depression immediately above it and the patella, which is rendered more evident by the relaxation of the extensors of the thigh; the leg is usually rotated somewhat inwards or outwards, and there is shortening to the extent of about two inches.

These antero-posterior dislocations are very commonly incomplete. When this is the case, they present the same symptoms, but in a less marked degree, that characterize the complete displacements.

In the *treatment* of these dislocations, extension should be made from the ankle whilst the thigh is fixed in a semiflexed position. When the leg has been drawn down sufficiently, proper manipulation will bring the bones into accurate position; splints must then be applied, means taken to subdue local inflammation, and the joint kept perfectly at rest for two or three weeks, at the end of which time passive motion may be commenced.

Subluxation of the knee, or "internal derangement of the knee-joint," is an accident of more frequent occurrence than any of those that have just been described. It usually occurs from the patient, whilst walking, striking his toe against or tripping upon a stone, when he is suddenly seized with acute and sickening pain in the knee, often so severe as to cause him to fall to the ground. Before doing this, however, he is conscious of having strained or otherwise injured the joint. On examination it will be found semiflexed, the patient being unable to extend the limb properly, and every effort being attended by severe pain. In the course of a very short time the joint becomes swollen, being distended by synovial secretion; and symptoms of subacute synovitis are speedily superadded to the original injury.

This accident, originally described by Hey, and since investigated by Sir A. Cooper and others, occurs in consequence of the semilunar fibro-cartilage slipping away from under the internal condyle, either before or behind it, so as to bring the surface of the condyle and that of the tibia into direct apposition. The severe pain that is always experienced is owing, in all probability, to the nipping of the loose folds of synovial membrane that lie within the joint—the so-called mucous and alar ligaments, and also to the great stretching of the ligaments by the partial displacement of the bones.

The *reduction* may be effected by flexing the joint, and then, when the muscles are off their guard, the patient's attention being directed elsewhere, rapidly extending it at the same time that a movement of rotation is communicated to the leg. The evidence of complete reduction consists in the power of extending the articulation being regained by the patient. The synovitis that usually follows this injury requires to be treated by local antiphlogistics and rest. After it has been subdued, the patient should wear a laced knee-cap, as the joint will be weakened and liable to a recurrence of the same injury.

Complications.—Dislocations of the knee-joint are more liable to serious complications than those of any other articulation. Not only are the ligaments torn, and the muscles injured, but stretching, and perhaps laceration, of the popliteal vessels, followed by gangrene of the limb, may occur; or the joint may fall into a state of suppurative and destructive inflammation, as the result of the injury.

Compound dislocation of the knee-joint constitutes one of the most serious injuries to which the limbs are liable; the external wound being usually large, ragged, and accompanied by the protrusion of the condyles of the femur, with much laceration of the soft structures in the vicinity of the joint. These are cases that certainly, as a general rule, call imperatively for amputation; indeed, Sir A. Cooper regards this injury as one especially demanding removal of the limb. Cases, however, have

occurred in which the limb, even in these circumstance, has been saved. Hence, if the patient be young, and if the vessels of the ham do not appear to have been seriously injured, the wound in the soft parts at the same time not being very extensive, or much bruised, an attempt may with propriety be made to save the joint. In a case of compound dislocation of the knee forwards in a boy, the late Mr. A. White sawed off the projecting end of the femur which protruded through the ham, and, bringing the wound together, succeeded in saving the limb.

The *head of the fibula* has occasionally, though very rarely, been displaced by the application of direct violence to it. Boyer and Sanson have each recorded a case of this kind. One such case has occurred to me in my practice. It happened in a gentleman about 23 years of age, who, in descending an Alpine slope covered with snow, fell with one leg bent forcibly under him, so that he came down, as it were, in a sitting posture. The head of the fibula was thrown back off the articulating surface, and remained permanently in its new situation. The limb was somewhat weakened, so that the patient could not jump, but otherwise he suffered no inconvenience. The tendon of the outer hamstring was very tense, and when I saw the case, some length of time after the accident, its traction effectually prevented all attempts at reduction.

Dislocations of the Ankle occur in consequence of displacement of the astragalus from the bones of the leg, whilst it continues to preserve its normal connection with the rest of the foot. These dislocations are almost invariably connected with fracture of the lower end of the fibula, or of the inner malleolus. In fact, on looking at the arched cavity into which the astragalus is received, it is evident that this bone can scarcely be displaced laterally without fracture of one side of this arch. In considering these dislocations we must, in accordance with the general nomenclature of similar accidents, in which the distal part is always said to be displaced from the proximal, look upon the foot as being dislocated from the leg, and not consider the tibia as being displaced upon the foot. The direction of the dislocation must consequently be determined by the position into which the articular surface of the astragalus happens to be thrown. It is necessary to explain this, inasmuch as a good deal of ambiguity occurs in surgical writings from the same accident being described differently, according to the view taken of the part displaced. Thus, Sir A. Cooper speaks of the tibia as being dislocated at the ankle; whilst Boyer and others, regarding the foot as the part displaced, have described the same injury in directly opposite term.

Dislocations of the foot from the bones of the leg may take place in four directions, viz., *laterally, to either side; backwards;* or *forwards.* In all cases, the injury appears to be occasioned either by the foot being twisted under the patient in jumping or running; or else by its being suddenly arrested by coming into contact with the ground whilst the body is carried forwards. But, as has already been stated at page 219, these twists do not necessarily occasion dislocation, and must not be confounded with that accident.

The dislocation *outwards* is of most frequent occurrence. In it the inner malleolus projects forcibly against the skin; there is a depression above the outer ankle corresponding to a fracture of the fibula; and the sole of the foot is turned upwards and outwards, the inner side touching the ground, whilst the outer edge is turned up.

In the dislocation *inwards*, which is a rare accident, and, according to Sir A. Cooper, a much more dangerous one than that just described, the fibula is not fractured, but the lower end of the tibia is splintered off, in an oblique manner from within outwards. The outer edge of the sole rests against the ground, and the inner side is turned up.

The *reduction* of these lateral displacements is readily effected by simple traction into proper position; leg-splints with lateral foot-pieces must then be put on, or Dupuytren's splint may be applied on the same side as the dislocation, opposite to that on which the eversion of the foot takes place.

In the dislocation of the foot *backwards*, the deltoid ligament is ruptured, the fibula broken in the usual situation, and the tibia thrown forwards on the navicular and internal cuneiform bones; the foot is consequently shortened, and the heel rendered more projecting.

The dislocation *forwards*, in which the foot is lengthened, and the tibia thrown upon the upper and posterior surface of the os calcis, behind the astragalus, is an accident so rare as seldom to have been witnessed, although described.

In the *treatment* of these antero-posterior displacements of the ankle, traction of the foot in a proper direction, the leg being fixed and flexed upon the thigh, will readily be attended by replacement of the bones; the application of lateral splints being afterwards sufficient to keep the parts in proper position.

Compound dislocations of the ankle-joint are serious and by no means unfrequent accidents, the displacement occurring in the same direction and from the same causes as the simple forms of injury.

The *treatment* of compound dislocations of the ankle-joint must depend to a considerable extent upon the amount of laceration of the soft parts, and the condition of the bones forming the arch of the joint. If the wound in the soft parts be inconsiderable in extent, clean cut, and with little injury to the bones, the limb should be placed on a M'Intyre's splint; and the lips of the wound, being well cleaned, brought together by strapping, or covered by lint soaked in collodion; evaporating lotions may then be applied, the constitutional condition of the patient carefully attended to, and the case treated in much the same way as a compound fracture. In many instances this plan will suffice, and the patient will recover with a stiff but useful limb, the joint being only partially anchylosed.

If, however, the bones be projecting and comminuted, and the wound more extensively lacerated, the question of amputation will necessarily arise. In many cases, the operation may be dispensed with by adopting the treatment recommended by Hey, of sawing off the malleoli, removing splinters of bone, cleaning the wound, bringing together its edges by simple dressing, and supporting the limb at the same time upon a M'Intyre's splint. If the joint be still more seriously injured, the posterior tibial artery torn, or the foot greatly contused, or if the patient's constitution be shattered and irritable, recourse should be had to primary amputation. I believe, however, that the disinclination on the part of surgeons to amputate in these cases, owing to the strong expression of opinion by Sir A. Cooper in favor of the attempt to save the limb, has in many cases been carried to such an extent as seriously to endanger the patient's life. Secondary amputation may be rendered necessary in consequence of gangrene, erysipelas, or extensive suppuration.

Dislocations of the Astragalus.—The astragalus is occasionally displaced from its connection with the bones of the leg above, and with those of the tarsus below, being thrown either *forwards* or *backwards*, the displacement forwards happening far more frequently than that in the opposite direction. In the dislocation *forwards*, the head of the bone may be thrown either *outwards* or *inwards;* but I do not think there is any evidence to show that complete lateral dislocation of this bone can occur irrespective of displacement forwards; the so-called *lateral* dislocations being displacements of the bone forwards, with twists to one or the other side. The dislocation *forwards*, with lateral inclination, may either be *complete* or *incomplete.* When it is *complete*, the bone is thrown out of its bed on the calcaneum, and separated from its connections with the malleolar arch above and the scaphoid in front, being forced in front of the tarsus, and lying upon the scaphoid and cuneiform bones. When the dislocation is *incomplete*, the head is separated from the scaphoid, and is thrown up on the external cuneiform or cuboid bones, the body of the astragalus maintaining its connections with the malleolar arch and os calcis. The dislocation *backwards* is, I believe, always *complete.* In the luxation backwards there is no rotation of the bone, which is thrown directly behind the tibia, in the space between it and the tendo Achillis.

These dislocations invariably happen from falls upon or twists of the foot; more particularly when it is in a state of extension upon the leg. When the foot is in this position, the lower end of the tibia either breaks off on the application of sufficient violence, or the head of the astragalus is forced out of the cavity of the scaphoid and its bed on the os calcis; the particular kind of displacement that occurs depending upon the direction in which the force is acting and in which the foot is twisted. And, as the foot is more frequently twisted inwards, the head of the astragalus is thrown outwards. Dislocation of the astragalus differs from dislocation of the foot in this—that when the foot is dislocated, the astragalus, though thrown out from under the malleolar arch, preserves its connections with the rest of the tarsus; whilst these are always broken through when the astragalus is the bone dislocated, even though it have not completely escaped from between the malleoli.

The dislocation of the astragalus *forwards*, with twist of the bone *inwards*, is

said to be of most common occurrence: I have, however, more frequently witnessed that form of accident in which the bone is thrown somewhat *outwards* as well as forwards. In either case the displaced bone forms a distinct tumor upon the instep, in the outline of which the form of the astragalus can be distinctly made out. Over this, the skin is so tightly drawn as often to appear to be on the point of bursting. When the bone is thrown somewhat inwards the foot is turned outwards, and the internal malleolus projects distinctly. When the astragalus is thrown *outwards*, displacement of the foot in an inward direction, with great projection of the lower end of the fibula, takes place. In some cases, fracture of the neck of the astragalus is conjoined with these dislocations; and not uncommonly the luxation is compound from the very first, or speedily becomes so if left unreduced, in consequence of the sloughing of the skin which covers the anterior surface of the bones, the exposed portion of which undergoes necrosis, and perhaps eventual exfoliation.

The dislocation *backwards*, into the hollow under the tendo Achillis, is of rare occurrence, there being but seven recorded instances of this accident. In the majority of these there was displacement of the bone *inwards*, as well as backwards. In these cases the diagnosis is easy, as the bone forms a distinct prominence, which can be felt under the tendo Achillis.

In many cases the dislocation of the astragalus is not altogether complete, the under surface of the tibia not coming into direct contact with the upper surface of the os calcis; a portion of the astragalus still intervening between these bones.

Treatment.—The reduction of the dislocation *forwards*, whether attended by lateral displacement or not, varies greatly in the facility of its execution; in some instances being effected with the greatest possible ease, in others being attended by almost insurmountable difficulties. This difference in the facility or reduction depends, I think, on whether the dislocation is complete or not. When the astragalus is not completely thrown from under the arch formed by the bones of the leg, a portion of it being still entangled between their articular surfaces and that of the calcaneum, it may usually be readily reduced by relaxing the muscles of the calf, and pushing the bone back into its proper position. But when the astragalus is completely dislocated, the upper surface of the calcaneum is drawn up under the arch of the malleoli by all the strength of the muscles that pass from the leg to be inserted into the foot. In these circumstances, in order that the reduction take place, it is necessary first of all to separate the articular surfaces to such an extent as to admit of the astragalus being pushed back into its socket: this is almost impossible, owing to the great perpendicular thickness of this bone, to the extent to to which it is consequently necessary to draw down the foot, and to the little purchase that can be obtained on it. In such cases as these, reduction has been greatly facilitated by the division of the tendo Achillis, by which simple operation the whole strain of the muscles of the calf is taken off.

If reduction be still impracticable, and the bone continue to be unreduced and irreducible on the dorsum of the foot, what should then be done? Two courses present themselves to the surgeon; either at once to cut down upon the astragalus and to remove it from its new position; or to adopt a palliative treatment—to put the limb at rest on a splint, to apply evaporating lotions, and to wait the result, acting according to circumstances as they develop themselves. In some rare cases the displaced astragalus has given rise to comparatively little inconvenience; but this can seldom be expected. If the dislocation have been in the direction forwards, the skin will usually slough, and then a portion of the exposed osseous surface, which will probably necrose, may be excised, or the whole of the astragalus may be dissected out by freely exposing it, and severing its ligamentous attachments; the patient recovering with a somewhat stiffened, but still useful joint. This plan appears to be safer than excising the bone in the first instance, so soon as the dislocation has been found to be irreducible.

[Desault succeeded in one case in effecting reduction by dividing the restraining ligamentous attachments of the astragalus with the knife: the case did well. Perhaps this plan might be advantageously tried before resorting to excision.—A.]

In luxation *backwards*, the bone has not hitherto to my knowledge been reduced, except in one case which occurred in University College Hospital, and in which the tibia and fibula were also fractured. It is by no means improbable that subcutaneous division of the tendo Achillis may in future enable the surgeon to effect reduction. The result is, however, satisfactory, even though the bone be not reduced,

the patient recovering with a useful foot. If the dislocation be left unreduced, the soft parts covering the bone may slough, as has happened in a case recorded by Dr. Williams, of Dublin, in which the bone was consequently extracted.

In *compound dislocation of the astragalus* (Fig. 167), the rule of practice must depend upon the extent of injury. If the integuments have merely been rent in consequence of the tension to which they have been subjected by the outward pressure of the displaced bone, an attempt must be made to reduce the dislocation, aided, if necessary, by the division of the tendo Achillis; and, if this be effected, to close the wound by the first intention. If the bone be comminuted as well as dislocated, the proper practice will be to remove the loosened fragments, and to dress the wound in the simplest manner, allowing it to heal by granulation. If the bone be irreducible, it is a question whether it should be left or dissected out. If it be left, the wound in the integuments will certainly extend by a sloughing process, the bone will inflame and become carious or necrosed, exfoliating in fragments, and the patient will only recover after a prolonged, tedious, and dangerous course of treatment. In these circumstances, therefore, it appears to me that the simpler and safer plan both to limb and life consists in enlarging the wound in proper directions, so as to dissect out the irreducible astragalus, and then bringing the articulating surfaces into contact, dressing the parts lightly, and trusting to the formation of a new joint between the tibia and the os calcis. So, also, if a simple dislocation of the astragalus become compound in consequence of the sloughing of the superjacent tense integuments, the exposed and necrosing bone should be removed in part or in whole, according to the circumstances of the case. If together with the dislocation of the astragalus, the foot be extensively crushed, amputation may be required either at the ankle-joint or at some convenient part of the leg.

Fig. 167.

Dissection of foot in compound dislocation of astragalus outwards.

Dislocations of the other Tarsal Bones are of extremely rare occurrence. Most of these bones, however, have been found luxated at times.

The *calcaneum* and *scaphoid*, carrying with them the rest of the foot, are sometimes dislocated from the astragalus, which is left *in situ* under the malleolar arch. In these dislocations the bone may be displaced in either lateral direction—outwards or inwards. The *treatment* consists in the flexion of the leg and attempts at reduction by extension of the foot in the ordinary way. If moderate extension fail in effecting reduction, M. Pallsel has recommended the division of the tendo Achillis, and, if necessary, of the posterior tibial tendon, as a means of facilitating this, on the same principle in which it has been done in dislocation of the astragalus itself.

The *calcaneum* has been dislocated laterally from its connection with the cuboid in consequence of falls from a height, the sufferer alighting upon his heel. Chelius mentions a case in which this bone was dislocated by the effort of drawing off a tight boot. *Reduction* seems to be readily effected by relaxing the muscles, and pressing the bone back into its proper position.

The *scaphoid* and *cuboid bones* have been found to be dislocated upwards, in consequence of a person jumping from a height and alighting upon the ball of the foot. In these instances the limb is shortened and curiously distorted, the toes pointing downwards, and the arch of the instep being increased so as to resemble closely enough the deformity of club-foot. *Reduction* may be effected by drawing and pressing the parts into position.

The *great cuneiform bone* has occasionally been found to be dislocated. Sir A. Cooper mentions an instance of this kind. If reduction be not effected by pressing the bone into its position, no great evil appears to result to the patient, the motions of the limb not being seriously interfered with.

Sometimes the tarsal joints are extensively torn open without any one bone being

distinctly dislocated. I have seen this happen to a young man who caught his foot between the spokes of a revolving wheel, in whom the foot was violently bent and twisted, and all the tarsal joints more or less torn open. Those between the scaphoid and cuneiform bones, the calcaneo-cuboid and calcaneo-astragaloid, as well as the ankle-joint itself, were especially injured, so as to necessitate amputation.

Dislocation of the Metatarsal Bones, though excessively rare, from the manner in which these bones are locked into the tarsus, and retained by short and strong ligaments, yet occasionally occurs; instances being recorded by Dupuytren and Smith. Liston also mentions a case of luxation of the metatarsal bone of the great toe from direct violence. Tufnell records a case of luxation downwards and backwards of the inner three metatarsal bones, from a fall upon the leg by a horse rolling on its rider. Two cases have occurred in my practice, in one of which, by the pressure of a "turn-table" on a railway, the *outer* three metatarsal bones were dislocated downwards. In the other, in consequence of a horse falling and rolling on its rider, there were a compound dislocation of the first and a simple dislocation of the fourth metatarsal bone. The question of amputation will always present itself in these cases, and must be determined on general principles, by the age of the patient, and the extent of injury to the soft parts.

Luxations of the *phalanges of the toes* but rarely happen, and present nothing pecial in nature or treatment.

INJURIES OF REGIONS.

CHAPTER XXII.

INJURIES OF THE HEAD.

The consideration of injuries of the head is one of the most important studies that can engage the surgeon's attention. The importance attached to it is not so much due to the special considerations connected with the mere injury of the scalp and skull, as to the effects that are produced as the result of the implication of the brain and its membranes, in many cases directly, and in others indirectly and remotely, owing to the anatomical connections and consequent close pathological sympathies that subsist between the external and internal structures of the head. In consequence of this tendency to cerebral complication, it is of the first moment in practice to study these injuries as a whole, with special regard to the affections of the encephalon that are produced by them, and from which the injury of the scalp and the fracture of the skull derive the greater part of their importance. It is therefore necessary, in the first instance, to be acquainted with the nature and treatment of the principal forms of cerebral affection that supervene upon these accidents, before we proceed to study the special nature and peculiar modifications of treatment required by the conditions that occasion them.

CEREBRAL COMPLICATIONS OF INJURIES OF THE HEAD.

These may be primary or secondary. There are three principal *primary states of functional disturbance* arising from injury to which the brain is subject, viz., 1. Concussion, 2. Compression, and 3. Cerebral irritation. Any one of these may be followed by, or be complicated with, inflammatory actions of various kinds, that derive much of their peculiar characteristics from the conditions with which they are associated, and from the injuries by which they are occasioned.

In describing these different conditions, we are compelled to define the symptoms that characterize them more distinctly than is the case in actual practice, where they are not so closely individualized, but become merged together to a considerable extent.

1. **Concussion of the Brain.**—Concussion, or stunning, appears to be a shock communicated to the nervous system from the application of such external violence as will produce commotion of the substance of the brain, or interfere with the circulation through it; in consequence of which its functions become temporarily suspended, usually in a slight and transitory degree, but occasionally to such an extent that the patient does not rally for many hours from the depressed state into which he is thrown, and perhaps sinks without recovery.

The *pathology* of concussion of the brain is very obscure. The reason of this is obvious; few people die from simple concussion. In those cases in which death has occurred from other causes during a state of cerebral concussion, it has been found that the disturbance of the functions of the brain constituting concussion has been due to actual lesion of its substance. In some cases, congestion has been found in the vessels of the brain and its membranes. In others, again, portions of the cerebral substance, varying in size from points to patches an inch or more in diameter, have been found to be disintegrated and more or less ecchymosed. In the more severe and fatal cases of concussion of the brain, it will be found that the cerebral substance is disorganized to a much greater extent than this; in fact, in these cases those conditions of the brain that are characteristic of contusion become apparent.

The *signs* of concussion vary according to the severity of the injury to the brain. In the slighter cases, the patient may merely feel giddy and confused for a few minutes. In others, again, consciousness is not affected, but he feels faint and weak, being unable to stand. In the more severe forms—in that degree, indeed, which usually accompanies any severe injury of the head—the surface becomes cold and pale; the sufferer is motionless and insensible, or only answers when spoken to in a loud voice, relapsing again into speedy insensibility, or rather semi-consciousness; the pulse is feeble, the pupils are contracted, and the sphincters usually relaxed; the limbs are flaccid, and muscular power is lost. After this condition, which is the first stage of concussion, has lasted for a few minutes or hours, according to the severity of the shock, the second stage comes on; the circulation gradually re-establishing itself, the pulse becoming fuller, and the surface warmer. About this time the patient very commonly vomits; the straining accompanying this effort appears to be of service in stimulating the heart's action, and driving the blood with more vigor to the paralyzed brain, thus tending to restore its functions; and we accordingly find that, after vomiting has occurred, the sufferer quickly rallies. In the more severe cases the symptoms that have just been described are so strongly marked that the patient appears to be moribund; there is complete prostration of all nervous and physical power; the surface being cold and death-like, the eyes glassy, the pupils either contracted or widely dilated, the pulse scarcely perceptible and intermittent. In this state the patient may lie for hours, recovery being slow, and the concussion merging into some other and perhaps more serious affection of the nervous centres; or, indeed, in some cases, speedily terminating in death, apparently by failure of the heart's action.

The *terminations* of concussion are various. We have already seen that in some cases this affection may speedily give way to complete recovery; although slight headache, some degree of giddiness, confusion of thought, and inaptitude for mental occupation, may last for a few days before the mental powers are completely re-established. In other cases, again, the concussion may rapidly terminate in the patient's death; but between these conditions there are several intermediate states. Thus, the recovery may be complete, but a permanently irritable state of brain may be left; the patient, though capable of the ordinary duties of life, becoming readily excited by slight excesses in diet or in the use of stimulants, or by mental emotion, though not of an inordinate intensity. Individuals thus affected, suffering from a preternaturally irritable brain, frequently die suddenly in the course of a few months, or a year or two after the receipt of the injury.

In other cases the recovery continues to be incomplete; although the patient may be enabled to follow his usual occupation, and to mix in the ordinary business of life, yet his state is a precarious one, the brain being liable to the occurrence of inflammatory disease on the slightest exciting cause. In such cases as these, there is frequently a certain degree of impairment of mental power, the memory failing either generally or in certain important points, as with reference to dates, persons, places, or language. The speech is perhaps indistinct and stuttering. Amaurosis of one or both eyes, with perhaps squinting or paralysis of the eyelid, may be left.

The hearing may be impaired, or noises of various kinds set up in the ears. There may be diminution or loss of muscular and of virile power, especially, as Hennen observes, in those cases in which the injury has been inflicted upon the back of the head; and Holberton has noticed that, when the medulla oblongata has been injured, the pulse may continue preternaturally slow—an observation which I have had several opportunities of confirming in injuries both of the medulla, the pons, and the crura cerebri. For these symptoms to occur, it is by no means necessary that the original local injury should have been a severe one. In some cases, in railway accidents more especially, or in falls from a height, the whole nervous system appears to be jarred and concussed without any wound or apparent sign of external injury to the head. At first, the symptoms of concussion are but slight, perhaps even none are apparent, and the sufferer congratulates himself on his escape; but gradually impairment of nervous power, manifesting itself in one or other of the ways just mentioned, comes on, and the health continues broken through life.

In other cases, again, the symptoms of concussion may gradually terminate in those of compression; and not unfrequently the reaction that comes on, passing beyond the bounds that are necessary for the re-establishment of the healthy functions of the brain, terminates in an inflammatory condition of this organ. Liston has truly observed, that no injury of the head is too trivial to be despised, or too serious to despaired of.

2. **Compression of the Brain.**—This is a common condition in injuries of the head, arising as it does from a great variety of causes: from the pressure of a portion of bone, of blood extravasated, or of pus formed within the skull, or from a foreign body lodged there. In whatever way occasioned, however, the symptoms, although presenting some differences, are tolerably constant. The patient lies in a state of coma, stupor or lethargy, being paralyzed more or less completely, heavy, insensible, and drowsy, not answering when spoken to, or only when addressed in a loud voice, and perhaps shaken at the same time. The breathing is carried on slowly and deeply, with a stertorous or snoring noise, and usually a peculiar blowing of the lips. The stertor appears to be owing to paralysis of the velum pendulum palati, which, hanging down as an inanimate curtain, is thrown into vibrations during expiration by the passage of the air across it; the distension of the cheeks and blowing of the lips are due to the loss of tonicity in these structures. One or both pupils are dilated; the pulse is full, often slow; the feces pass involuntarily, from paralysis of the sphincter ani, and the urine is not uncommonly retained, from paralysis of the bladder; the skin may be cool, but in many cases, on the contrary, is rather hot and perhaps perspiring. Not unfrequently this state of stupor alternates with paroxysms of delirium, or of local convulsive action.

This state of coma may become complicated by the occurrence of symptoms of inflammation: and, unless the cause that produces the compression be removed, it usually terminates speedily in death, the patient gradually sinking into more complete unconsciousness, and dying in an apoplectic condition. In other, but much rarer cases, the coma may continue almost an indefinite time, for many weeks or even months, until the compressing cause is removed, when the patient may recover consciousness, and the symptoms suddenly disappear.

The *diagnosis* between *concussion* and *coma* has been sufficiently indicated in the preceding description of these two conditions not to require special mention here. But it must be remembered that, in many cases, one state merges into the other, so that the symptoms are not so distinctly marked as has been indicated, and they are more especially obscured when associated with inflammatory action.

3. **Cerebral Irritation.**—The third form of primary cerebral disturbance which is met with in injuries of the head, differs very remarkably from both the preceding. In it the patient presents symptoms neither of concussion nor of compression, nor is there any combination of the phenomena characterizing these two states; but the symptoms are altogether peculiar. For convenience of description, they may be divided into two groups, the *bodily* and the *mental*.

The *bodily symptoms* are as follow: The attitude of the patient is peculiar and most characteristic: he lies on the side, and is curled up in a state of general flexion. The body is bent forwards, the knees are drawn up on the abdomen, the legs bent, the arms flexed, and the hands drawn in. He does not lie motionless, but is restless, and often, when irritated, tosses himself about. But, however rest-

less he may be, he never stretches himself out nor assumes the supine position, but invariably reverts to the attitude of flexion. The eyelids are firmly closed, and he resists violently every effort made to open them; if this be effected, the pupils will be found to be contracted. The surface is pale and cool, or even cold. There is no heat of head. The pulse is small, feeble, and slow, seldom above seventy. The sphincters are not usually affected, and the patient will pass urine when the bladder requires to be emptied; there may, however, though rarely, be retention.

The *mental state* is equally peculiar. Irritability of mind is the prevailing characteristic. The patient is unconscious, takes no heed of what passes, unless called to in a loud tone of voice, when he shows signs of irritability of temper, or frowns, turns away hastily, mutters indistinctly, and grinds his teeth. It appears as if the temper, as much as or more than the intellect, were affected in this condition. He sleeps without stertor.

The course taken by these symptoms is as follows: After a period varying from one week to three, the pulse improves in tone, the temperature of the body increases, the tendency to flexion subsides, and the patient lies stretched out. The mental state also changes. Irritability gives way to fatuity; there is less manifestation of temper, but more weakness of mind. Recovery is slow, but, though delayed, may at length be perfect; although in these, as in all other cases of cerebral disturbance, ulterior consequences may be manifested.

This form of cerebral disturbance may, from the peculiar irritability that characterizes it, be with propriety termed *cerebral irritation.*

The symptoms that have just been described usually follow blows upon the temple or forehead, and probably in many cases may arise from, or are associated with, lacerations of the cerebral substance, more especially of the gray matter.

The substance of the brain may be contused or bruised by blows upon the head. This condition of the brain may occur either at the seat of injury, or as the result of *contrecoup*, at an opposite point in the cerebral hemisphere. Being struck on the right side of the head, the patient may suffer from contusion of the opposite part of the left hemisphere, or *vice versâ*. In this injury of the cerebral substance, we have many of the symptoms that are characteristic of cerebral irritation; but in addition to them it will occasionally happen that there is more or less coma, in consequence of extravasation of blood, or there may be paralysis, facial or hemiplegic. In other circumstances, or possibly associated with these conditions, there may be convulsive movements more or less epileptiform in character. These may be confined to the face, may extend to the paralyzed limbs, or may occupy the opposite side of the body.

The *prognosis* in these cases is serious, but by no means necessarily fatal. In fact, in a majority of instances, recovery ensues.

The *secondary consequences* of injury to the brain consists of, 1, inflammation; and 2, the deposit of pus and other inflammatory exudations upon or within that organ and its membranes.

1. **Traumatic Encephalitis.**—Inflammation of the brain and its membranes from injury (*traumatic encephalitis*), is an affection of great frequency and corresponding importance. It is a condition that is specially apt to supervene on all injuries of the head; though the liability to it necessarily increases with the severity of the accident. This form of inflammation of the brain and its membranes may set in with great intensity in some cases, the symptoms of phrenitis being strongly marked; in other instances, it gradually creeps on in a slow and insidious manner, not attracting attention until it has given rise to some severe and ulterior consequences, as effusion or suppuration, when its symptoms become so mixed up with those of compression and of irritation, as to make the exact diagnosis of the patient's condition far from easy. The period at which inflammatory symptoms of the brain may manifest themselves, after an injury of the head, varies greatly. In some instances they set in almost immediately on the patient recovering from the effects of the concussion; the reaction from this state gradually assuming an inflammatory character. In other cases, it is not until after the lapse of several days that inflammation declares itself; and, again, it sometimes happens that the inflammatory affection does not supervene for weeks or months: but then, occurring perhaps under the influence of comparatively trivial causes, it may destroy the patient.

Pathological Changes.—After death, we usually find both the brain and its membranes inflamed. The arachnoid is, however, the structure that appears principally

to suffer in these cases, being thickened, so as to become milky and semi-opaque. Adherent lymph, of a greenish-yellow color and opaque purulent appearance, is seen covering one or both hemispheres of the brain, being deposited in largest quantity at the seat of the injury, and not unfrequently extending across and into its fissures, occupying especially the depressions about its base. The vascularity of the brain and its membranes is greatly increased; the arachnoid being reddened in patches, and the vessels of the pia mater becoming turgid and very numerous, forming a vascular network over the surface of the brain. The sinuses also are distended with blood; the cerebral substance exhibits an increase in the quantity of red points, so as often to present a somewhat rosy hue; and the ventricles are filled with reddish semiturbid serum, a large quantity of which is effused about the base of the brain. In some of the more advanced cases, inflammatory softening of the cerebral substance may occur.

Symptoms.—In considering the symptoms of traumatic encephalitis, it is useless to endeavor to make a distinction between the inflammation of the brain and that of its membranes; the two structures being always more or less implicated at the same time. The most practical division of this disease following injury, is into the *acute* and the *chronic* or *subacute encephalitis.*

Acute encephalitis usually comes on within eight-and-forty hours of the infliction of the injury. The patient complains of severe, constant, and increasing pain in the head; the scalp is hot, the carotids beat forcibly, the pupils are contracted, the eyes intolerant of light, and the ears of noise; the pulse is full, vibrating, and bounding; and wakefulness, with delirium, usually of a violent character, speedily comes on. All the symptoms of severe constitutional pyrexia set in at the same time.

By active and proper treatment this condition may gradually subside until the health is re-established, but more commonly the symptoms of inflammation merge into those of compression; the delirium becoming replaced partly or in whole by a state of stupor, from which the patient is roused with difficulty, the pupils gradually dilating, the breathing becoming heavy and stertorous, the pulse sometimes continuing with its former rapidity, at others becoming slow and oppressed. The skin is hot but clammy; the patient falls into a heavy, dull, unconscious state, which alternates with convulsive twitchings or jerkings, and occasional delirious outbreaks. As death approaches, the sphincters become relaxed, the pulse more feeble, the surface cooler, and the coma more intense and continuous, until the patient sinks from exhaustion and compression conjoined. In cases of this kind, pus may be found upon the surface or within the substance of the brain, in one case being diffused, in the other collected into a more or less distinctly circumscribed abscess. In other cases, again, the symptoms of compression appear to be induced by a thick layer of lymph lying upon the surface of the brain, or by a quantity of serous fluid being poured out into the ventricles and about the base.

Chronic or *subacute encephalitis* is the most interesting and important variety of inflammation following injuries of the head. It may come on a few days after the infliction of the injury, or not until months have elapsed. It may arise from accidents that simply implicate the skull, as well as from those that extend their direct effects to the brain and its membranes. The patient in many cases has apparently recovered entirely from the accident, though in others it will be found that some one symptom indicative of the brooding mischief still continues, such as headache, or impairment of sight or of hearing. Occasionally, the coming mischief is foreshadowed by an unusual degree of irritability of temper, by loss of mental vigor, or by some other functional disturbance of the brain. In cases such as these, the subacute encephalitis may suddenly come on, ushered in perhaps by an aggravation of the persistent symptom, or by the occurrence of an epileptic fit. In other cases again, the symptoms set in suddenly without any warning, but usually with much intensity, and speedily prove fatal.

The *symptoms* of subacute encephalitis, when it has fairly set in, consist of those of inflammation, irritation, and compression of the brain conjoined; in some cases one, in other instances another, of the conditions appearing to predominate. The irritation and inflammation proceed from the increased vascular action; the compression from the effusion of serous fluid, of pus, or of lymph, exercising undue pressure upon the brain. The symptoms consist of pain in the head with heat of the scalp, and either dilatation or contraction of the pupils, occasionally one being

dilated and the other contracted. Squinting, intolerance of light, delirium, moaning, or screaming, unconsciousness, with convulsive twitchings of the limbs and face, commonly occur with the ordinary symptomatic fever; and lastly, symptoms of coma, rapidly terminating in the patient's death.

In the subacute encephalitis, the same appearances are very generally found after death, as in the more acute form of the affection; but it commonly happens that it is the arachnoid membrane that is principally affected. So constantly is this the case, that some surgeons have proposed, and not altogether with injustice, to apply the term *arachnitis* to this form of traumatic encephalitis, looking upon the inflammation of the arachnoid as the principal lesion.

2. **Intracranial Suppuration.**—This may be of three distinct kinds: 1. Subcranial; 2. Intrameningeal; 3. Cerebral.

The *subcranial* form consists in the deposit of pus between the skull and the dura mater. It always occurs at the point struck, and is limited or circumscribed. It is never the result of *contrecoup.*

Three conditions may lead to this variety of intracranial suppuration.

1. A blow on the head which, with or without wound of the scalp or fracture of the skull, causes a separation of the dura mater from the bone, leaving a gap or hollow in which inflammatory effusions and eventually pus collect.

2. A blow on the head causing necrosis of the bone, either by simple severe contusion, or by detaching it from the dura mater and stripping off the pericranium—thus disturbing its vascular connections, and so giving rise to suppuration under the portion of bone injured.

3. The irritation of splinters of the inner table in cases of ordinary depressed or of punctured fractures of the skull, causing chronic inflammation of the dura mater and eventual suppuration. In these cases it is often found associated with one or both of the next varieties.

The *intrameningeal* form consists in the accumulation of pus, or of greenish puriform lymph in the cavity of the arachnoid, or in its deposit in the pia mater. It is usually widely diffused, most generally beneath the part struck; but sometimes on the opposite side of the head, always more towards the vertex than in any other part. It commonly occurs in persons of low vitality—in pyæmic cases—and is associated with typhoid symptoms.

The *intracerebral* form is usually met with as a distinct circumscribed abscess in the white substance of the hemispheres, often associated with the last variety, and occurring in individuals of low unhealthy habit of body. It may occur: 1. At the seat of injury; 2. By *contrecoup;* or, 3. It may be the consequence of the lodgement of foreign bodies in the brain.

The formation of pus within the skull is a sequence of much interest in injuries of the head; and an endeavor has been made, especially by Pott, to lay down rules by which its occurrence may be accurately determined. Thus it has been said that if, during the continuance of encephalitis, fits of shivering come on, followed by the gradual supervention of coma, which slowly becomes more and more complete, whilst the constitutional symptoms of inflammation do not subside; and if, at the same time, a puffy swelling form upon the uninjured scalp, or the wound, if any, become pale and cease to secrete, the pericranium separating from the bone, which is seen to be yellow-brown and dry, an abscess will have formed under the skull; and further, that in all probability its seat will correspond to these changes in the scalp and pericranium, which are due to the bone having lost its vitality by being separated from the dura mater by the subjacent abscess—hence their importance.

In many cases, doubtless, this progression of constitutional symptoms, accompanied by the two local signs just mentioned, has afforded proof of the existence of intracranial suppuration. It but seldom happens, however, that the signs attending the formation of pus within the skull occur in the distinct order and with the degree of precision above stated. In the great majority of cases, the surgeon can only suspect the presence of pus by the symptoms of inflammation terminating in paralysis or coma. But he cannot say with certainty that pus has formed, for the coma may arise from the pressure of other inflammatory effusions; but if the puffy swelling of the scalp or the separation of the pericranium occurs, with exposure of dry and yellow bone, with hemiplegia on the opposite side, then he may feel himself justified in giving a more positive opinion as to its existence in some situation within

the cranial cavity, probably beneath or in the immediate neighborhood of the part thus affected.

Pyæmia, with its characteristic visceral secondary abscesses, is by no means an unfrequent complication of injuries of the head. It may occur as a consequence of any lesion of the scalp, skull, or brain, in which the patient survives sufficiently long for the development of the characteristic phenomena of this disease. As this is of necessity chiefly the case in the slighter forms of cerebral injury, it is after these that purulent infection and secondary abscesses have principally been met with; occasionally after wounds of the scalp, rarely after those of the brain or its membrane, but more commonly and not unfrequently after injury of the skull, more especially after severe contusions of the bone without fracture.

The sequence of pathological phenomena in these cases is the same that is observed in all in which pyæmia follows injury or wound of the osseous structures. The part of the bone that is struck usually necroses; inflammation and suppuration are set up in the surrounding portions of the skull; the cells of the diploë, cancellated in structure, become filled with pus; its veins, which are large and sinuous, inflame, and become the media of transmitting pus to the general circulation; the ordinary constitutional symptoms of pyæmia develop themselves, and secondary abscesses eventually form in the lungs, liver, and joints, with lowly organized plastic effusions into the serous cavities, more particularly those of the pleura and pericardium. The older writers on surgery had noted and had marvelled at the strange phenomenon of hepatic abscess following slight head-injuries, and had generally overlooked the occurrence of secondary deposits in other organs and structures. More modern investigation has shown that these abscesses are pyæmic, that they are a part of a general purulent infection of the system, and that they almost invariably are accompanied by pulmonary abscesses; indeed, it is these and not the hepatic that are the common consequences of pyæmia resulting from cerebral injury. Of eighteen cases, P. Hewett found the lungs studded with abscesses in thirteen, and the liver in three; and of these three, in one case only was the liver alone affected. It has been supposed by some that intracranial suppuration is a necessary precursor of these secondary abscesses: that it frequently coexists is undoubted—we often meet with pus in these cases between the dura mater and the contused bone; but to suppose that it is a necessary concomitant, is an error. I have seen cases in which the most extensive secondary deposits were found in the lungs, liver, joints, &c., but in which not a drop of pus existed in the interior of the skull in any part; but I have never seen a case in which the diploë around the injured bone did not contain pus, sometimes diffused through its cells, sometimes filling its venous sinuses.

When intracranial suppuration coexists with secondary pyæmic deposits, the symptoms of the two conditions become so mixed up as to lead to considerable difficulty in establishing a certain diagnosis; but when the intracranial suppuration is not developed, there may be a complete absence of all cerebral disturbance, whilst the alternating rigors and heat of pyæmia, the oppressed breathing, or the hepatic tenderness, with hiccup or recurring sickness, and the articular tenderness, give unmistakable evidence of the formation of secondary abscesses.

The prognosis of these cases is necessarily in the highest degree unfavorable. I doubt much whether recovery is possible when once pyæmia, consequent on head-injury, has advanced to the formation of secondary visceral abscesses.

Treatment.—The treatment of these various cerebral injuries, and their concomitant affections, is one of the most important and difficult subjects that can arrest the surgeon's attention; the difficulty depending in a great measure on the various conditions that have just been described not occurring in practice with that amount of distinctness and individuality by which their characters can alone be conveyed in description, but being associated together in such a way that the exact state of the patient cannot so readily be made out. There are few cases, indeed, in which practical tact and a nice discrimination and analysis of symptoms are more required than in those now under consideration. It would, however, be useless to attempt to describe the shades and modifications of treatment required in the management of the different groupings of these various forms of traumatic cerebral disturbance. We must, therefore, content ourselves with describing the treatment of each state broadly and separately, and leave the consideration of the varieties that so commonly present themselves in practice to the individual tact of the surgeon.

In the *treatment of concussion*, the first great indication is to re-establish the depressed energies of the circulation and of the nervous system. In effecting this, we must, however, be careful not to overstimulate the patient. The safest practice is that which is applicable to the treatment of shock generally; to wrap the patient up warmly in blankets, to put hot bottles around him, to employ frictions to the surface, and, when he is sufficiently recovered, to allow him to swallow a small quantity of warm tea. Alcoholic stimulants of all kinds should be avoided, as their effects may be injurious; unless the depression of the nervous energy be so great that reaction cannot be brought about without their agency. But an enema containing some ether or aromatic spirits of ammonia may be administered.

When reaction has come on, steps should be taken to prevent the occurrence of inflammatory mischief. With this view, if the concussion have been slight, it may be quite sufficient to purge the patient well, and to keep him quiet on a regulated diet for a few days, directing him carefully to avoid all alcoholic stimulants and mental exertion for some time. If the concussion have been more severe, and if the symptoms of reaction have been accompanied by indications of continuous cerebral disturbance, or have been followed by giddiness, headache, or confusion of thought, the safer plan will be to adopt immediate steps for the prevention of mischief. The patient should be bled generally, or locally by leeches and cupping, freely purged, kept on a low diet, and, above all, should remain quiet in bed for some days.

Should impairment of the mental faculties or senses be left, the more prudent plan will be to have recourse to mild antiphlogistic treatment. Leeching, cupping, blistering, the introduction of a seton in the nape of the neck, purging, and more especially a mild mercurial course, with strict avoidance of all mental and bodily stimulation, is the plan of treatment that requires to be pursued. These cases must, however, be carefully watched, and kept under proper supervision for some length of time, as serious symptoms are apt suddenly to declare themselves.

When *acute inflammation of the brain or its membranes* has come on, at whatever period after the injury, active treatment should be at once adopted. The head must, be shaved, and an ice-bladder kept constantly applied. Bleeding from the arm, repeated as often as the pulse rises, as well as by cupping, or leeches, must be had recourse to; the bowels should be freely opened, and rigid abstinence must be enjoined, the patient at the same time being confined to a quiet and darkened room, and removed from all causes of excitement of the special senses. Calomel should then be administered, so as speedily to affect the mouth. As the disease assumes a chronic form, the same general plan of treatment, modified according to the intensity of the inflammatory affection, must be persevered in, the patient being kept for a length of time after the subsidence of all the symptoms in a state of complete quietude.

The *subacute encephalitis* which occasionally follows injuries of the head, even at a remote period from their infliction, is a most dangerous and unmanageable affection, being very apt to terminate in loss or impairment of sense, in diminution of intellectual power, or in local paralysis. Much of the difficulty in the treatment of these cases appears to arise from the fact that the inflammation is often of a low and erysipelatous character, consequently not admitting of active depletory measures.

In these cases the best results are obtained by the proper administration of mercury and the employment of counterirritants. The best mode of administering the mercury is to give calomel in small and repeated doses, half a grain or a grain every four or six hours until the gums are affected, and to keep them so by diminishing, but not leaving off the mineral. The repeated application of blisters over the shaven scalp is perhaps the most useful form of counterirritant; to which, in more chronic cases, a seton in the neck may be added. So long as any symptoms of inflammatory action continue, this plan of treatment must be steadily kept up.

The treatment of *cerebral irritation* that I have found most successful, consists in the avoidance of all very active measures. No good, but much harm, may result in these cases from bleeding, purging, and mercurializing the patient. Complete rest, the removal of all mental and sensual excitement, shaving the head, the application of cold, a mild aperient or an occasional enema, are all that can be done in the way of medical treatment. As the constitutional powers are depressed, they must not be too much lowered by complete abstinence from food, and small quantities of stimulants may usually be advantageously given. A teaspoonful of brandy

in a little water, or beef tea, every hour or two, according to the condition of the pulse and the temperature of the skin, will generally be required. In some cases, where there is great restlessness and some delirium, without any sign of encephalitis having supervened, an opiate may quiet the patient and induce sleep. This cerebral irritation is the only form of primary cerebral disturbance in which I have seen opiates act beneficially; but their administration requires great care, and must not be ventured on if there be any heat of head or quickness of pulse.

In all cases of *coma from compression*, the pressure must be relieved before it can be expected that the coma will subside. But, besides this great and obvious indication, which must be carried out in different ways according to the nature of the compressing cause, there are certain general considerations to be attended to by which the patient's condition may be much relieved. Thus the bowels should be freely opened by placing a drop of croton oil, mixed with a little mucilage, in the patient's mouth, or by the use of oleaginous or terebinthinate enemata. The urine is to be drawn off twice in the twenty-four hours, the room darkened, and kept quiet, and ice or an evaporating lotion applied to the head.

When symptoms of compression occur as the result of *inflammation inside the skull*, the treatment becomes surrounded by difficulties. If, notwithstanding antiphlogistic measures have been pushed to their full extent, rigors occur and coma supervene, conjoined with a certain amount of continuous inflammatory action, the question will always arise as to whether trephining should be had recourse to, on the supposition of matter having formed. In these cases two great difficulties present themselves; the first has reference to the existence of pus within the skull, and the second to its situation.

The question as to the actual existence of *pus within the skull*, and the dependence of the symptoms of coma upon the compression exercised by the purulent deposit, is always a difficult one to determine. There are, as has already been stated, no absolute and unequivocal symptoms indicative of the formation of pus within the skull; the symptoms that accompany its formation being often closely simulated by the effusion of serum, or of puriform lymph, on the brain or its membranes. But although there may not be any symptom that is absolutely and unequivocally indicative of the formation of pus in this situation, it not unfrequently happens that the surgeon is enabled, by the assemblage of general symptoms and local signs, to indicate its existence with considerable accuracy. In these cases, however, it is usually impossible to determine the exact seat of the purulent deposit with sufficient precision to admit of its evacuation by the trephine—whether the pus be between the skull and the dura mater, between the layers of the arachnoid, underneath this membrane, between the cerebral convolutions, or deeply seated in the substance of the brain; whether it be situated under the seat of injury and be there circumscribed; or whether it be so extensively diffused as not to be capable of complete evacuation. That these difficulties are real, must be obvious to every practical surgeon; and in illustration of them I may mention the following two cases, out of many that I have witnessed.

A man was admitted into University College Hospital with an extensive lacerated wound of the scalp, denuding the pericranium. He continued free from all cerebral disturbance until the tenth day after the accident, when he complained of headache, had a quick pulse, and a hot skin. At this time it was observed that the denuded pericranium had separated from the skull. He was treated by active antiphlogistic means, the symptoms subsiding, and went on favorably until the thirty-fourth day, when he suddenly became delirious and unconscious, though easily roused when spoken to loudly, and then answering rationally; his pulse fell to 48. He died on the thirty-ninth day, comatose. On examination after death, the pericranium was found detached at the seat of injury; under this the dura mater was thick, yellow, and opaque, but no pus was observable. On separating the hemispheres, however, a large abscess was found situated deeply in the anterior lobe on the injured side, and protruding into the median fissure. It contained about one ounce of pus. In such a case as this trephining would evidently have been useless; for although it was probable that there was pus within the skull, yet its seat could not have been diagnosed, and the abscess could never have been reached.

Another case that was admitted into the hospital, was that of a man who had received a large lacerated wound on the left side of the scalp in consequence of a fall. There was no injury to the bone, and the patient went on perfectly well until

the seventy-seventh day, the wound cicatrizing. He was then suddenly seized with hemiplegia of the right side, from which he recovered partially on being bled; some twitching of the muscles, however, continued. On the ninety-ninth day after the accident he became comatose, and was trephined by Mr. S. Cooper, but without relief, dying with symptoms of compression of the brain on the third day after the operation. On examination thick yellow lymph was found, covering the whole of the upper surface of both hemispheres, lying between the arachnoid and pia mater, and extending into the sulci between the convolutions. There was an abscess in the substance of the brain on the surface of the right hemisphere, on the side opposite to the seat of injury. Here also, though the symptoms were well marked, and the diagnosis as to the existence of pus correct, trephining was useless as the pus could not be evacuated. These cases serve to indicate the difficulties that surround any operation with the view of evacuating matter from within the cranium.

When, however, the symptoms of inflammation have been interrupted by an attack of rigors followed by coma, or accompanied by hemiplegic paralysis on the side opposite to the seat of injury, with the formation of a puffy swelling of the scalp, or by the separation of the pericranium and the exposure of yellow and dry bone at the bottom of the wound, there can be little doubt that the surgeon, though bearing in mind the extreme uncertainty of the case, might be justified in trephining at the seat of local change or of injury, in the hope of finding and evacuating pus deposited beneath the skull, and thus giving the patient his only chance of life. And indeed, if the *local* changes just described be well marked, the bone being dry, having lost its vitality, and during the operation being cut without bleeding from the diploë, the probability of finding pus immediately beneath the trephine aperture, and seeing it well up by the side of the instrument as the bone is perforated, is very great. And should it not be met with there, and the dura mater appear bulging, and without pulsation, an incision might even be made through this membrane, in the hope that, the abscess being circumscribed, the escape of the pus might be facilitated. Should this attempt fail, there are few surgeons who would have the hardihood to follow the example of Dupuytren, who plunged a bistoury into the substance of the brain, and thus luckily relieved the patient of an abscess in this situation. Yet, even though pus be actually found under the skull, between it and the dura mater, and be evacuated, I fear that the patient's chances of recovery will not be very materially increased, as the encephalitis will continue, and eventually lead to his death. In my own experience, I have never met with a case of recovery under these circumstances; and P. Hewett states that the successful termination of a case of trephining for pus within the skull, even between it and the dura mater, is all but unknown to surgeons of the present day. Yet, in the face of this unfavorable prospect, it appears to me that trephining is the proper course to pursue. There can be no doubt from the records of surgery, that patients have occasionally recovered who have been trephined for intracranial suppuration; and, as the pus cannot evacuate itself, it is perfectly certain that death must ensue if it be not let out. As the only chance of life, therefore, rests with the trephine, it appears to me to be proper to have recourse to this, however doubtful may be the result of its application.

The *treatment of pyæmia* from injury of the skull must be conducted on those ordinary medical principles that guide us in the management of pyæmia, from whatever cause arising. There is only one point of a purely surgical character connected with it, and it is this: Should recourse be had to trephining in cases of contusion of the cranium as a means of preventing the development of pyæmia? In answer to this, I would say, that experience has not demonstrated the utility of this procedure; that it would be impossible in any given case of contusion of the cranium to say whether necrosis or suppuration of the bruised bone would occur; that it would be still more difficult to limit the extent of that probable necrosis, and to remove it all by the trephine; that the operation itself is attended by grave dangers of its own, and would inflict an additional injury on the diploë; that it could scarcely be considered as likely to be attended by any benefit in rescuing the patient from the possible danger of pyæmia; and that, therefore, in the face of such uncertainties and of such possible dangers, so serious an operation as trephining the skull would not be justifiable.

INJURIES OF THE SCALP.

Contusions of the Scalp from blows are of common occurrence, and present some peculiarities that deserve attention. However severe the contusion may be, it seldom happens that the scalp sloughs. This is evidently owing to the great vascularity and consequent active vitality of the integuments of the head. In many cases a contusion in this situation is followed by considerable extravasation of blood, raising up the scalp into a soft semi-fluctuating tumor. It occasionally happens, especially in blows on the heads of children, that this extravasation gives rise to the supposition that fracture exists, owing to the edge of the contusion feeling hard, whilst the centre is soft, apparently from the depression of the subjacent bone. In some cases, indeed, this deceptive feeling will occur without any considerable extravasation of blood under the scalp, the depressed centre being due to the compression of the scalp by the blow that has been inflicted upon it. This I have seen occasionally in children in whom the scalp is soft and somewhat spongy. The difficulty of distinguishing between such an extravasation and a piece of depressed bone, is often so great as to mislead the most experienced surgeons. Usually it can be effected by feeling the smooth bone at the bottom of the soft central depression, and by an absence of symptoms of compression. But in the event of doubt, it will be safer to make an incision, and so to examine directly the state of the bone itself.

The *treatment* of contusion of the scalp is very simple; the continuous application of evaporating lotions being usually sufficient for the removal of all effusion. In no circumstances should a puncture be made or the blood let out in any way. Contusions of the scalp in girls and young women have been known to be followed by severe neuralgic pains in the part struck. This affection is extremely rebellious to treatment; but in two cases which I have seen, after lasting for a considerable length of time, these symptoms gradually disappeared; in such cases as these, incisions down to the bone are said to have sometimes been beneficial.

Cephalhæmatoma.—It occasionally happens that bloody tumors of the scalp form in newly-born children, either from contusion of the head in consequence of the pressure to which it is subjected in its passage; or from the bruising of obstetric instruments. These tumors, which are often large and fluctuating, are termed *cephalhæmatomata*. They may occur in two situations, either *between the aponeurotic structure of the scalp and the pericranium*, or *between this membrane and the skull itself*.

The *subaponeurotic cephalhæmatoma* is by far the most common variety of the affection. It usually forms a large, soft, fluctuating tumor, situated upon one of the parietal eminences, and having a somewhat indurated circumference. The tumor may usually be made to subside in a few days by the use of discutient lotions.

The *subpericranial cephalhæmatoma* is an injury of extremely rare occurrence; but Zeller, Valleix, and others, have determined its existence. It appears as a fluctuating tumor, without discoloration of the scalp, but with a hard elevated circle around it, and a soft depressed centre, almost communicating the sensation of a hole in the cranium. Pressure, however, gives rise to no cerebral symptoms, and enables the surgeon to feel the osseous lamina at the bottom of the depression. These tumors are usually small, seldom larger than a walnut, and it not uncommonly happens that they are multiple. It is worthy of note, however, that each tumor is always confined to a separate bone, never passing beyond the sutures, where the adhesions are the strongest between the pericranium and the subjacent osseous structure. This affection is said to be most frequently met with in children born in first confinements, and is more common in boys than in girls; according to Bouchard, in the proportion of thirty-four to nine.

The *pathology* of this affection has been studied by Valleix. This surgeon found that the pericranium was separated from the bone by an extravasation of blood, and that both bone and pericranium were covered with plastic matter, but otherwise healthy. He also found that the hard circle surrounding the depression was formed by a deposit of osseous and plastic matter which bounded the extravasation. This deposit was effected in such a way that, on a transverse section being made, the inner wall was found nearly perpendicular, whilst the outer sloped down upon the cranium, thus giving a crateriform appearance to the margin of the tumor.

The *treatment* of this affection must be conducted upon precisely the same principles as that of the other forms of scalp-extravasation.

Wounds of the Scalp are of very common occurrence, and are more serious than corresponding injuries elsewhere, especially in persons about the middle period of life, and of unhealthy or broken constitution. It is not only that these injuries are more likely to be followed by erysipelas than those of other parts of the body, but it is also to the great tendency to the propagation of inflammatory mischief inwards to the encephalon, and to the complication of cerebral mischief, so often accompanying comparatively slight injuries of the scalp, that these accidents owe much of their serious and often fatal character. But, though there be this danger to life in scalp-injuries, there is comparatively little risk to the scalp itself; the abundant supply of blood which it receives from closely subjacent arteries, and its consequent great vitality, furnish the reason why sloughing so seldom occurs, even though the part be much bruised and seriously lacerated.

The *treatment* of wound of the scalp necessarily varies somewhat according to the nature of the injury. If this be a simple cut, it will be sufficient, after shaving the parts around and cleansing its interior, to bring it together with a strip or two of adhesive plaster, and to dress it as lightly as possible. If the incision in the scalp be extensive, the lips of the wound must be brought together by a few points of metallic suture, or by hare-lip pins. If there be arterial hemorrhage, this may usually be best arrested by passing the pins across and under the bleeding vessel, and compressing this with a figure-of-8 suture. In this, as in all other cases of injury of the head, especial attention should be paid to the state of the brain; for, however slight the external wound may be, serious cerebral mischief may have been occasioned; or, at all events, the same blow that has caused the cut in the scalp may have given rise to such functional derangement of the brain, as may eventually lead to the worst forms of traumatic encephalitis.

[It is especially in scalp wounds that Dr. Goddard's gauze and collodion dressing is applicable. Bleeding may be checked by means of a firm compress, which will also serve a good purpose in preventing the formation of a cavity for the accumulation of pus.—A.]

It more frequently happens that the scalp is bruised and lacerated as well as wounded; and very commonly that a large flap of integument is stripped off the skull, and is thrown down over the face or ear, so as to denude the bones. In these cases, advantage is taken of the great vitality of the scalp. However extensively contused or lacerated this may be, however much it may be begrimed with dirt, it is a golden rule in surgery not to cut any portion of it away, but, after shaving the head and ligaturing any bleeding vessels, to wash and clean it thoroughly, and replace it in its proper position. Here it must be retained by the support of a few strips of plaster, or by the application of a suture or two at the points of greatest traction: for this purpose, thick silver-wire is better than silk or thread. The use of sutures has been deprecated by many surgeons in injuries of the scalp, as tending to favor erysipelas; and undoubtedly much mischief will arise if an attempt be made to stitch up the wound closely, and in small wounds they are generally unnecessary. But in extensive lacerations, more particularly of the anterior part of the scalp, so that the soft parts are stripped off, and will hand over the occiput as the patient lies down, they cannot be dispensed with; and here I have never seen any but the best consequences follow their use at those points where the torn surfaces can be readily approximated. In cases of this kind, the under surface of the scalp granulates, and union by the second intention takes place between it and the pericranium. If the edges do not come properly together, a piece of water-dressing may be applied; but the head must be kept cool, and as little bandaging and plastering had recourse to as possible. The patient should be freely purged, and kept perfectly at rest on a rather low diet; any cerebral symptoms that occur being treated in accordance with the principles laid down in discussing traumatic affections of the brain. In this way, union will very probably take place through the greater portion of the injured surface; should it not do so, however, or should any part slough, granulations spring up, and reparative action goes on with surprising rapidity. If matter form beneath the aponeurosis of the occipito-frontalis muscle, extensive bagging must be prevented by early counter-openings, and by the employment of compression in proper directions. Whenever suppuration takes place beneath the frontal portion of the muscle, the pus has a special tendency to gravitate into the upper

eyelid, and here the counter-opening may be conveniently made. If simple erysipelas supervene, that disease will require to be treated in accordance with ordinary surgical principles. So far as the wound in the scalp is concerned, that must be thrown open, all dressings removed, and, if matter form, a free outlet must be afforded to the pus. If diffuse cellulitis occur, recourse must be had to free incisions through the puffy and swollen scalp, and counter-openings for the discharge of pus and sloughs.

When the skull itself is extensively denuded in consequence of the pericranium being stripped off the subjacent bone together with a flap of the scalp, it does not necessarily follow that necrosis and exfoliation of the exposed bone will occur. In cases of this kind the flap must be laid down on the denuded osseous surface, to which it may possibly contract adhesion through the medium of granulation. Should it, however, slough, and a large portion of the skull be even exposed, exfoliation of the outer table, though probable, does not necessarily happen; for, in some cases, instead of exfoliating, the exposed portion of the skull will inflame, plastic matter be thrown out, and, granulations springing up, a covering be formed to the bone.

Contusion of the Cranial Bones without fracture, occasioned either by ordinary direct violence or by the oblique impact of bullets, is a very serious injury, more particularly when complicated with wound of the scalp. In it there are three sources of danger, any one of which may be followed by a fatal result: viz., 1. Necrosis of the part of bone struck, leading to exfoliation of the outer table, or to separation of the whole thickness of the cranium and exposure of the dura mater; 2. Suppuration under the skull, between it and the dura mater; and, 3. Pyæmia with secondary visceral abscesses, in consequence of the suppuration of the diploë around the necrosed point of bone, and the entrance of pus into the cranial veins—a condition to which reference has already been made.

FRACTURES OF THE SKULL.

Injuries of the bones of the skull, especially fracture, possess great interest, not so much from the lesion of the bone itself, as from its frequent complication with injury of the brain and its membranes. This cerebral complication may either be produced by direct injury, occasioned by the fragments of the fractured bone compressing or wounding the brain; or it may be the result of concussion or laceration of the brain by the same violence that occasions the fracture.

Causes and Varieties.—Fractures of the skull are invariably the result of external violence. This may act *directly* in breaking and splintering the part struck, the fissures often extending to a considerable distance and detaching large portions of the skull; or the violence may act in an *indirect* manner, producing the fracture either without being applied immediately to the cranium, or else at an opposite part of the skull to that which is struck. Thus the base of the skull may be fractured by the shock communicated to it when a person, falling from a height, strikes the ground heavily with his feet. The other variety of indirect fracture, that in which the solution of continuity occurs at a point of the skull opposite to that which has been struck, is the *fracture by contrecoup.*

Fracture by Contrecoup.—This has been described by some surgeons as of frequent occurrence, whilst it has been denied by others. There can, however, be no doubt that it does happen, though less commonly, perhaps, than is generally supposed. Every hospital surgeon must occasionally have seen unequivocal instances of it. For its occurrence, several conditions are necessary. The skull must be struck over a large surface, as when a person falls with his head against the ground. If a blow alight on a thin portion of it, this will be directly fractured; but if a dense and strong part of the bone be struck, as the parietal eminence, or the lower part of the os frontis, the shock transmitted through the skull generally will cause the thinnest and most brittle portions of it, though distant, to give way in preference to the stronger part on which the blow has immediately fallen. The fracture by *contrecoup* is most common at the base of the skull, and is commonly much radiated. It is never depressed.

Simple Fracture.—An ordinary simple or *undepressed fracture* of the skull consists in a fissure, sometimes single, at other times starred, extending often to a considerable distance through the bones, radiating sometimes across the skull, and

in other cases completely detaching its upper from its lower, or its anterior from its posterior segment. In some cases the fracture extends into one of the sutures; and in other instances, which, however, are very rare, the sutures are separated without any fracture.

The injury usually occurs from direct violence, but is also the only form of fracture that happens by *contrecoup*. A fissure or fracture, such as this, gives rise to no signs by which its diagnosis can be effected, and often escapes detection altogether, more particularly when the scalp covering it is not wounded, or, if contused, when so large a quantity of blood is extravasated as to render it impossible for the surgeon to feel the subjacent bone. If, however, the scalp covering the injured bone have been wounded, its existence may be ascertained by running the finger-nail, or the end of a probe, over the exposed surface of the bone, or by seeing a fissure into which the blood sinks.

As the whole importance and danger of fracture of the skull depends, not upon the injury that the bone has sustained, but on the concomitant or secondary lesions of which the contents of the cranium are the seat, no special *treatment* is required to the fracture itself when simple and undepressed, the surgeon's whole attention being directed to the concomitant injury that may have been inflicted on the brain or scalp. Active precautionary measures should be adopted without delay, with the view of guarding against the occurrence of inflammation of the brain and its membranes, even though no symptoms have as yet declared themselves. So soon as the patient has recovered from the concussion, his head should be shaved, an ice-bladder applied, and blood freely taken away from the arm; the bowels should be well opened, and the room kept cool and quiet. The employment of free and repeated bleeding is, however, of more service than any other means, and should never be omitted.

In *chronic hydrocephalus*, the cranial bones are thinned and expanded; but, being at the same time preternaturally elastic and mobile, are seldom fractured. When they are so injured, the presence of the water may save the brain from the direct effects of the blow. In one case that was under my care, the hydrocephalic child fell from the top of a house on to its head, and sustained a long fracture through the left side of the skull, but without any scalp-wound. Shortly after the accident, a large soft fluctuating tumor formed under the scalp opposite the line of fracture; and, on this being tapped, about three ounces of hydrocephalic fluid was drawn off. This operation was repeated, but the child died about ten days after the injury, with hemiplegia of the opposite side, and convulsions.

Fracture of the Base of the Skull.—The most serious, and indeed a very commonly fatal form of simple fracture of the skull, is that which extends through its *base*. This injury is usually produced by a fall from a height or a blow upon the vertex or side of the head, producing a fracture which extends from the point struck across the base of the skull, often running through the petrous portion of the temporal bone or into the foramen magnum. It may also take place as the result of *contrecoup*, or from a person falling from a height on his head, and having the base of the skull broken in by the weight of the body projected against it. The great danger in these cases is the concomitant injury to the brain, either by its direct laceration or by the extravasation of blood under it. Though most usually fatal, these injuries are not invariably so. Not only does it occasionally happen that patients with all those signs of fracture of the base of the skull, which will immediately be described, are seen to make a complete recovery, but, in the different museums, specimens illustrative of recovery after this accident may be met with. Thus, in the College of Surgeons' museum, there is the skull of a person who lived two years after a fracture of its base.

Signs.—The occurrence of fracture of the base of the skull is very commonly suspected when symptoms indicative of very serious injury to the brain speedily follow a severe blow upon the head, owing to the greater liability to injury of those parts of the nervous centre that are most important to life, in this than in other fractures of the skull; the same violence that occasions the fracture injuring the contiguous portions of brain, or lacerating some of the large venous sinuses about the base of the skull, and thus giving rise to abundant intracranial extravasation of blood. These symptoms are necessarily in the highest degree equivocal; and much anxiety has consequently been evinced by surgeons to discover some special sign by which the occurrence of this particular fracture may be determined.

The signs of fracture of the base of the skull will necessarily vary according to the seat of injury. When the fissure extends through the *anterior fossa*, there may be extravasation of blood into the orbit or eyelid, or free hemorrhage from the nose. When it implicates the *middle fossa*, there is, in all probability, fracture of the petrous portion of the temporal bone, with rupture of the tympanum, and then there will be bleeding or a watery discharge from the ears. When the *posterior fossa* is the seat of injury, the signs are more equivocal, unless the fissure extend inwards to the petrous portion of the temporal bone, when the more characteristic signs will occur.

There are two signs, the occurrence of which, separately or together, leads to strong presumptive evidence in favor of the existence of this kind of fracture. These are, 1. The escape of blood from the interior of the cranium through the ears, nose, or into the orbit; and 2. The discharge of a serous fluid from the ears, and occasionally from other parts in connection with the base of the skull.

1. The occurrence of *bleeding from one or both ears* after an injury of the head cannot by itself be considered a sign of much importance, as it may arise from any violence by which the tympanum is ruptured, without the skull being necessarily fractured. If, however, the hemorrhage be considerable, trickling slowly out of the meatus in a continuous stream, if the blood with which the external ear is filled pulsate, and more especially if the bleeding be associated with other symptoms indicative of serious mischief within the head, and if it have been occasioned by a degree of violence sufficient to fracture the skull, we may look upon its supervention as a strong presumption that a fracture of the base of the skull, extending into the petrous portion of the temporal bone, has taken place, and that, perhaps, one of the venous sinuses in its neighborhood is torn.

Hemorrhage into the areolar tissue of the orbit and eyelid, giving rise to extensive ecchymosis of the lid, possibly with protrusion of the eyeball itself, often accompanies fractures of the orbital plate of the frontal bone. The ecchymosis that occurs in these cases arises from the filtration of the blood from the interior of the skull, through the fracture, into the loose areolar tissue contiguous to the injured bone. It differs remarkably in appearance from that resulting from a direct blow upon the eyelid—from a "black eye." In the latter case there is bruising of the skin, and the ecchymosis is in a great measure cutaneous, of a reddish purple color. In the ecchymosis from fracture, the hemorrhage is entirely subcutaneous: there is probably no bruising of the eyelid, but this is tense, greatly swollen, and of a purple color. The extravasation can clearly be seen not to be in the skin, but to shine through it.

This hemorrhage may be venous or arterial. When venous, it probably arises from laceration of the cavernous sinuses. When arterial, it may, as Hewett has shown, be the forerunner of a circumscribed traumatic aneurism of the orbit, attended by pulsation, bruit, and projection of the eyeball, requiring the deligation of the common carotid for its cure.

Bleeding from the nose and mouth may of course arise from any injury applied to these parts without the skull being implicated; yet in some cases of fracture of the skull the hemorrhage proceeds from the interior of the cranium, the blood escaping through a fissure in the roof of the nasal fossæ, and indicating a fracture through the ethmoid and sphenoid bones. In a patient of mine who died five weeks after an injury of the head, accompanied by bleeding from the nose, a fracture by *contrecoup* was found extending across one orbital plate of the frontal bone, and separating its articulation with the ethmoid. In this case, the nature of the injury was suspected from the fact of the nose itself having been uninjured by the blow, although the hemorrhage from it was very considerable and continuous; for it is in the quantity and duration of this hemorrhage that its value as a diagnostic sign of fracture of the base of the skull consists.

Vomiting of blood may occur in these cases, from the blood finding its way through the fractured ethmoid or sphenoid down the nose and through the posterior nares into the pharynx and stomach. In these cases the vomited blood is dark, clotted, and mixed with the contents of the stomach. In some rare cases, the blood that issues from the nose and mouth passes into these cavities through the Eustachian tube. The petrous portion of the temporal bone is fractured, and the middle ear opened; the tympanum, however, being unbroken, no bleeding by the ear ensues, but the blood escapes into the pharynx through the Eustachian tube. In some cases

there may be a combination of these different signs. Thus, in a patient of mine at the hospital, there were hemorrhage into the left orbit and from the left nostril, copious vomiting of blood, and bleeding from the right ear, following a blow upon the forehead. The diagnosis which was made during life, and which was verified after death, was a fissure of the skull extending through the left orbital plate of the frontal bone, the ethmoid, and probably the sphenoid on that side, and a fracture of the petrous portion of the right temporal bone.

2. The *discharge of a thin watery fluid* from the interior of the skull is a sign of rare occurrence; but, when it happens, it may be considered as pathognomonic of fracture of the base. Indeed, it is the most certain sign of this injury that we possess. This discharge usually takes place through the ear; but it may occur from the nose, of which I have seen one instance, and Robert mentions another. Still more rarely it takes place from a wound in the scalp communicating with the fracture; percolating through this, and so being poured out externally. The only instance of this kind with which I am acquainted is one which was communicated to me by one of the pupils of the college, as having occurred at the Penryn Infirmary a few years ago. A boy received a wound on the back of the head, with depressed and comminuted fracture of the skull. On the nineteenth day after the receipt of the injury, a large quantity of serous fluid began to escape through the wound, and continued to do so profusely until his death from coma four days later. At first the fluid that is discharged is usually tinged with blood, but this soon ceases, and it then flows clear.

There would consequently appear to be three situations—the ear, the nose, and a wound on the head—from which this discharge has been observed. It is an exceedingly valuable though most serious sign; and Robert, who has investigated this phenomenon with much closeness, states that the cases in which it happens always terminate fatally. This, however, is an error; for at least three cases have occurred at the University College Hospital, in which the patients, adults, recovered, although many ounces of fluid were discharged from the ear. It is usually associated with symptoms indicative of serious injury to the base of the brain; but to this there are also exceptions, for I have seen it take place in cases of injury of the head, unaccompanied by any severe cerebral symptoms. In all cases of recovery that I have witnessed, some deafness of the ear from which the discharge occurred has been left. Most generally it occurs in young people. Robert says that it does so invariably; but Hewett states that in most of the instances in which he has seen it the patients were above thirty years of age. In one of the cases that I have witnessed, the patient was fifty-eight years of age; and in six other instances in which I have observed it, the patients were all adults.

The *quantity* of fluid that is thus discharged is always very considerable, the pillow usually becoming soaked by it, and thus first attracting attention to it. It is often necessary to keep a piece of sponge or a pledget of lint against the ear, in order to prevent the fluid from wetting the patient as it trickles out; and, if a cup be so placed as to collect it, an ounce or two will speedily accumulate. Laugier states that he has seen a tumblerful discharged in a short time, and as much as twenty ounces have been known to be poured out in three days. The flow is usually continuous for several days, and then ceases. It is remarkable that the hearing, though usually lost, does not always appear to be destroyed in the ear from which the discharge takes place.

Although the occurrence of a watery discharge from the ear after certain injuries of the head had been observed by Van der Weil, O'Halloran, and Dease, in the early part and middle of the last century, no attention was paid to the subject by later surgical writers; and the subject appears to have been completely lost sight of until Laugier, in 1839, again directed the attention of surgeons to this interesting phenomenon. Since this period, it has been often observed and attentively studied; and the nature and the source of this discharge have been particularly investigated by Laugier, Chassaignac, Robert, and Guthrie. Its *physical and chemical characters* are those of a perfectly clear, limpid, and watery fluid, containing a considerable quantity of chloride of sodium, with a little albumen in solution, and some sugar. It is not coagulable by heat nor by nitric acid.

The *source* of this discharge has not as yet been investigated with all the attention that its importance requires. Laugier believed it to be the serum of the blood filtered through a crack in the petrous portion of the temporal bone, and so through

the ruptured tympanum. This explanation, however, is evidently not correct; for not only is blood extravasated in the living body incapable of this species of rapid and complete filtration, but the chemical composition of the fluid, which differs altogether from that of the serum of the blood, in containing a mere trace of albumen and double the quantity of chloride of sodium, is incompatible with this supposition. By others it has been supposed that the fluid is furnished by the internal ear, being a continuous discharge of the liquor Cotunnii; but its large quantity, and, above all, the fact of its occasionally escaping through the nose, establish the fallacy of this explanation. Again, it has been supposed, but without sufficient evidence, that the cavity of the arachnoid furnishes this secretion. But the arachnoid does not secrete sufficiently to furnish the quantity of fluid discharged; and if this membrane become irritated and the secretion increased, it would become opaque from lymph or pus admixed with it. Others have looked upon it as the saliva flowing back through the Eustachian tube, and thus entering the ear, and draining out through the ruptured tympanum; but the character of the fluid differs so completely from that of saliva as to render this supposition untenable. I think, with Robert, that there can be little doubt that this discharge consists of the cerebro-spinal fluid; for not only is it, in appearance and chemical composition, identical with this liquid, but there is no other source within the skull than the pia mater which can yield with equal rapidity so large a quantity of fluid; experiment on animals having shown that the cerebro-spinal fluid is rapidly reproduced after its evacuation. An additional point of analogy between this discharge and the cerebro-spinal fluid is to be found in the fact pointed out by C. Bernard, that they both contain a small quantity of sugar. In order that the fluid be discharged, the membranes of the brain must have been torn opposite the outlet by which it is poured forth. This has actually been ascertained to be the case, in carefully conducted dissections of injuries of the head in which this symptom has occurred. When it is discharged through the ear, the laceration, as Bérard has remarked, must have extended through the cul-de-sac of the arachnoid, which is prolonged around the auditory nerve in the internal auditory canal. When it is poured out through the nose, the fracture has probably extended through the cribriform plate of the ethmoid bone, and laid open the prolongation of arachnoid that surrounds the filaments of the olfactory nerve.

Treatment.—The treatment of fracture of the base of the skull must be conducted on those general principles that guide us in the management of simple fractures; no special means can be had recourse to, and in the great majority of cases a fatal termination speedily ensues.

Depressed Fracture of the Skull.—It occasionally though very rarely happens that, in consequence of a blow, a portion of the skull is depressed without being fractured, and even without any serious cerebral symptoms occurring. Such depressions without fracture can, however, only occur in children, whose skulls are soft and yielding. In adults it cannot happen without the occurrence of partial or incomplete fracture. Many, if not all, of the so-called "congenital depressions" that are met with in the skull are the result either of violence inflicted on the cranium at birth, usually in instrumental labors, or of falls and blows upon the head in early infancy. Such depressions are smooth, concave, and sometimes symmetrical, and present very different characters from the irregular outline of an ordinary fracture. They never present the characters of a fissure. A depression of the skull may be congenital, being produced in the way I have described; but there is no such thing as a congenital fissure of the skull.

In the *diagnosis* of depressed fracture, it is important to remember that the apparent depression produced by an extravasation under the scalp may simulate this injury very closely; for even an experienced surgeon may sometimes under these circumstances be deceived, and be induced to cut down on a suspected fracture when in reality none exists. This happens in consequence of the blood that is extravasated coagulating round the circumference of the contusion, whilst that which is in the centre remains fluid, so that a very deceptive sensation of a hollow with a hard rim is communicated to the finger.

Varieties.—Depressed fractures of the skull present many varieties. They may either be simple, without wound of the scalp; compound; or comminuted. In the majority of cases, whether the fracture be simple or compound, there is com-

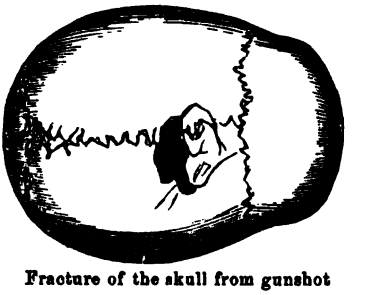
minution of the injured portion of bone; the fragments being perhaps driven into the brain.

Sometimes, though very rarely, the *external table* alone is depressed and driven into the diploë. This is especially the case over the frontal sinuses, where it may be broken in, as I have seen happen from the kick of a horse, without the inner table being splintered, or any bad consequences ensuing.

The *inner table* may be fractured without any injury whatever to the outer table; and it may not only be so fractured, but a portion of it may actually be depressed, without the outer table being injured. Of this remarkable injury several cases are recorded as having happened in the late American war, and are figured in the Official Surgical Report. More commonly, when the inner table is thus fractured or depressed, the outer table is fissured.

In all ordinary depressed fractures, the internal table is splintered to a greater extent than the external one. This is especially the case when the fracture is the result of gunshot injury, or when it has been occasioned by blows with a pointed weapon, as the end of a pick, or a large nail, or the sharp angle of a brick. In these fractures, which constitute the dangerous variety termed *punctured*, the outer table may be merely perforated or fissured, whilst the inner one is widely splintered into numerous fragments, for the extent of a square inch or more. This splintering of the inner lamina of the skull to a greater extent than the outer one has attracted much attention, being of considerable practical moment, and is usually said to be owing to its being more brittle than the external table. This, however, I do not consider to be the only cause. I should rather attribute it to the direction of the fracturing force from without inwards causing a certain loss of momentum in passing through the outer table; the inner table being thus splintered more widely than the outer one, for the same reason that the aperture of exit made by a bullet is larger than that of entry. If this be the true explanation, the reverse ought to hold good if the force be applied in the opposite direction. It is very seldom that we have an opportunity of examining such a case; but, a few years ago, a man was brought to the hospital who had committed suicide by discharging a pistol into his mouth and upwards through the brain. The bullet had perforated the palate and passed out at the upper part of the cranium, near the vertex (Fig. 168). On examining the state of the bones, it was found that the outer table of the skull was splintered to a considerably greater extent than the inner one, showing clearly the influence of the *direction* of the fracturing force. This case led me to make further experiments on the dead body; and I found that this always occurs when the blow is struck from the inside of the skull outwards.

Fig. 168.



Fracture of the skull from gunshot injury: splintering of outer table.

Mr. Teevan has recently made a considerable number of ingenious experiments on this subject, by firing bullets and driving pointed bodies of various kinds through the skull. He finds, as the result of these investigations, that the aperture of exit, or that opposite to the point struck, is the largest, whether the blow be delivered or the bullet be driven from without inwards, or the reverse. The explanation at which he has arrived, as the result of his experiments, is that the aperture of entry is caused by the penetrating body only, whilst the aperture of exit is caused by this *plus* the fragments of bone driven out of that table of the skull which was first perforated. Thus, when a bullet strikes the external table from without, it first perforates this, and then carries along with it and through the inner table the fragments of bone that it has cut out of the external table, and hence fractures the inner table more widely than the outer. When both sides of the head are traversed by a bullet, it will be found that the aperture of entry in the *outer* table on the side first struck, and the aperture of entry in the *inner* table of the opposite side of the head will be the smallest, the largest holes made by the bullet being the apertures on the inner table of the former side and the outer table of the latter. In the case of a large and broad body like a bullet, which carries and does not merely perforate bone, Mr. Teevan's explanation is doubtless correct. But, in the ordinary "punctured" fracture, made, for instance, by the point of a nail being driven through the

skull, it must be remembered that no fragments of the outer table or diploë are carried onwards, and that the very wide-spread splintering of the inner table, which is so characteristic of this form of injury, cannot be accounted for in this way, but appears to me to be referable to the cause I have given: viz., the *direction* of the fracturing force and the loss of momentum in the breaking body.

It occasionally happens, as the result of sabre or hatchet-cuts on the head, that a kind of longitudinal punctured fracture occurs, in which the outer table is merely notched, whilst the inner one is splintered along the whole line of blow. In other cases, again, a portion of the skull is completely sliced off, hanging down in a flap of the scalp, and exposing the brain or its membranes.

A special and very important kind of punctured and depressed fracture is that in which, by the thrust of a stick, umbrella, or other blunt-ended body into the orbit, the orbital plate of the frontal bone, or the cribriform lamella of the ethmoid, is perforated, and the dura mater or brain wounded. In such cases there is sometimes no external wound even, the stick having passed up under the upper eyelid; and it is conceivable that the same result even might happen by a thrust up the nostril. Death results either by wound of the cavernous sinus and intracranial extravasation of the blood, or more remotely from the secondary inflammatory effects of the wound of the dura mater and brain.

The *symptoms* of a depressed fracture of the skull are of two kinds: those that are dependent upon the injury to the bone, and those that result from the concomitant compression or laceration of the brain.

When the scalp is not wounded, the depression may sometimes be felt; but very commonly it is masked by extravasation of blood about it, and the surgeon is only led to suspect its existence by the continuance of symptoms of compression from the time of the injury. In all cases of doubt, when these symptoms exist, an incision should be made through the scalp at the seat of injury, and the state of the skull examined. When there is a wound in the scalp communicating with the fracture, the surgeon detects at once the existence of depression and comminution by examining the bone with his finger through the wound. When the fragments that are depressed are impacted and firmly locked together, so as to form an unyielding depression, symptoms of compression of the brain, to a more or less marked degree, usually result. But if the fracture be very extensive, and the fragments, though somewhat depressed, lie loose, and if they be yielding and do not exercise a continuous pressure on the brain, it occasionally happens that no cerebral disturbance comes on for some days, even though the injury done be very extensive. A man twenty-four years of age, was admitted into University College Hospital. He had been struck on the forehead with the sharp edge of a quoit. The frontal bone was extensively comminuted, twelve fragments being removed, and the dura mater being exposed to a considerable extent; yet no bad symptoms occurred until the ninth day, when inflammation of the brain and its membranes set in, and he speedily died.

In other cases again, more especially in children and young persons, in whom the bones are soft and yielding, fracture with depression may exist to a considerable extent, and no symptom whatever of compression be produced at the time or at any subsequent period, the patient living with a portion of his skull permanently beaten in. I have several times seen patients in after life with large flat depressions of the skull, the result of injuries sustained in childhood, who presented no signs of cerebral disturbance. It is very rare, however, to meet with a recent case of depressed fracture in the adult without signs of compression of the brain. But, though rare, it is not impossible; and Green mentions the case of a man whose skull was depressed to the extent of the bowl of a dessert-spoon, without any symptoms of compression.

Wounds of the Dura Mater.—The great danger in these cases of depressed and comminuted fracture arises not only from the compression of the brain, but from the rapidity with which inflammation is set up in consequence of the sharp fragments wounding and irritating the membranes and brain. Indeed, a wound of the dura mater, however slight, is a most dangerous complication, and one that is not often recovered from. This is more especially the case in those injuries in which the inner table is extensively splintered, as in the different forms of punctured fracture. In these cases there may be no signs of compression; but inflammation speedily sets in, and certainly proves fatal if the cause of irritation, the sharp spicula, be allowed to remain in contact with the dura mater. This membrane becomes sloughy, and coated with a thick deposit of plastic matter, whilst the usual

evidences of encephalitis are found in the other membranes and the brain. Wounds of the dura mater, though in the highest degree dangerous, are not necessarily fatal. In military practice it has often happened that, as the result of sabre-cuts, portions of the skull have been sliced or split down, the subjacent membranes and the brain itself being wounded, and yet a good recovery has resulted; and I have had several cases under my own care in which, though the dura mater has been punctured by spicula of depressed fractures, and portions of brain lost, the patient has made a good recovery.

The *treatment* of a depressed and comminuted fracture of the skull varies not only according to the nature and extent of the accident, but also to the existence or absence of symptoms of compression of the brain.

If there be no wound in the scalp, but the occurrence of symptoms of compression and the existence of some irregularity of the skull at the seat of injury lead the surgeon to suspect a depressed fracture, he should make a crucial or T-shaped incision down upon the part in order to examine the bone, and, if this be found depressed, to elevate or remove it.

If the scalp be already wounded, all that need be done to ascertain the nature of the fracture, is to pass the finger very gently into the wound and thus examine the bone. If any fragments be found lying loose, they should be picked out, as their presence can only excite injurious irritation; any bone that is driven below its level must be raised, and, if completely detached, removed.

In order to raise these depressed portions of bone, it is in many cases only necessary to introduce the point of an elevator underneath the fragment, and using the instrument as a lever, raise it into position. If there be not an aperture sufficiently large for the introduction of the elevator, one may be made by sawing out an angle of bone at a convenient spot by means of a Hey's saw, or clipping off a projecting point with the bone-forceps. In this way, sufficient space may usually be gained without the necessity of applying the trephine. If, however, the inner table be splintered to a considerable extent, or if there be no convenient angle that can be removed, the trephine must be applied in such a way that at least half its circle is situated upon the edge that overhangs the depressed bone; the surgeon sawing out by means of this instrument a portion of the undepressed skull, in order that he may more conveniently get at the fragment. After a half circle of bone has been removed in this way, the depressed splinters may be taken out, a Hey's saw still being occasionally required before the whole can be removed; the flaps of scalp should then be laid down, a suture or two applied, and water-dressing put over the wound. Rigorous antiphlogistic treatment must then be adopted with the view of preventing or removing the inflammatory symptoms which set in.

In all cases that partake of the nature of a *punctured fracture*, those in which there is but slight injury of the external table, with considerable splintering and depression of the inner one, or in which there is a narrow and deep depression of the bone, the trephine must be applied on different principles from those that guide us in its use in ordinary depressed fractures. In the punctured fracture it is applied, not to remove symptoms of compression which, in all probability, may not exist; but with the view of preventing the inflammation which will to a certainty be set up if the splinters of the inner table be allowed to continue irritating the membranes and brain. Hence it is a rule in surgery, in all cases of punctured fracture, to apply the trephine at once, so as to prevent those injurious consequences which must otherwise necessarily result. In these cases a trephine with a large crown should be used, and the circle of injured bone itself must be sawn out.

Should, however, the use of the trephine have been delayed in these cases until inflammatory action has been set up, the instrument may still be applied with advantage. Many years ago, a boy was admitted into University College Hospital, on the sixteenth day after having been struck on the side of the head by a large nail, which projected from a door that fell upon him. No symptoms of any kind had occurred until the eleventh day after the accident, when he became dull and lost his appetite; on the sixteenth day, that of his admission, he had suddenly become drowsy and delirious, but answered rationally when spoken to, and complained of pain in the head. The pupils were dilated, the skin hot, and the pulse quick. On examination, a small round aperture, from which some fetid pus exuded, was discovered on the right parietal eminence. On introducing a probe, which the hole just admitted, some rough bone could be felt. S. Cooper immediately trephined

the boy, removing a circle of bone including the small aperture. The inner table corresponding to this was found splintered to some extent, and the dura mater was seen to be thickened and inflamed; but the patient recovered without a bad symptom.

In those rare cases in which there is *a depressed fracture, without symptoms of compression*, or even a wound of the scalp, the line of practice is somewhat unsettled, as to whether the depressed portion of bone should be left where it is, or an attempt be made to elevate it. Sir A. Cooper, Abernethy, and Dupuytren advise that, if it does not give rise to any symptoms of compression, it is better not to interfere with it; and there are several cases on record of patients who have recovered in whom this course was adopted, the depression continuing permanent. That non-interference is the proper course to pursue in some cases, more particularly in children, there can be no doubt. I have had under my care a child in whom, in consequence of a fall, there was on one of the parietal bones a depression as large as a crown-piece, its edges being sharply defined: no signs of compression or of inflammation of the brain ensued, and it was consequently left without interference, the child making an excellent recovery, and continuing well. Indeed, in children, the amount of injury that may be inflicted on the brain not only by compression but by actual laceration, and yet be followed by recovery, is very surprising.

In the adult, the cerebral substance does not accommodate itself so readily to injuries, and here the line of practice is not quite so definite. But even in persons of mature age, under certain favorable circumstances, bone may be depressed and continue so without giving rise either to compression of the brain or to inflammation of its membranes. I had once under my care a case which illustrated this point forcibly. The patient, a middle-aged man, fell on his head into an area, and stripped off the greater part of the scalp from the anterior part of the head and the vertex; on the upper part of the left parietal bone was a starred and depressed fracture of the skull, as large as a florin. As the depression was smooth, not more than a quarter of an inch in depth, and there was no symptom of compression, I drew the scalp forwards and left the bone untouched, the patient making an excellent recovery, without any symptom of intracranial mischief. I am also acquainted with a gentleman upwards of fifty years of age, who has a depression in the parietal bone as large as the bowl of a tablespoon, the result of a fracture by a fall from a horse when a lad, and from which no inconvenience has resulted. I think, however, that this expectant practice should not be followed too implicitly, but that we must be guided by the circumstances of the particular case. If the depression be nearly uniform, of inconsiderable depth, and occupy some extent of skull, which is depressed in a smooth hollow or bowl-like manner, and more especially if the patient be young and the scalp unwounded, it may be better doubtless to follow the practice of the above-named great surgeons, and to wait for symptoms of compression manifesting themselves before we interfere. If, however, the scalp be wounded, the depression be sharp, deep, and comparatively small in extent, we may reasonably suspect the existence of considerable splintering of the inner table; and here, I think the safer plan would be, even in the absence of all symptoms of compression, to elevate for the same reason that we trephine in punctured fracture—the prevention of inflammatory action that will be occasioned by the irritation of the splinters of the inner table. I would not, however, venture to dogmatize on this very important and difficult point of practice. The opinions of the most experienced surgeons are at variance; and cases may readily be adduced on either side in support of conflicting doctrines. It would appear that military surgeons generally are in favor of the expectant plan, and cases may be found in the works of Guthrie, Ballingall, &c., in support of this practice; and it is a remarkable circumstance that, in many of these instances in which recovery resulted in cases of depressed fracture of the skull which were not subjected to operative interference, the patients were exposed to great privations, possibly during a hurried retreat, and left in circumstances apparently the least favorable to recovery. So far as my own experience is concerned, which is necessarily drawn purely from civil practice, I can say that, with the exception of the case that has just been referred to, I do not recollect ever having seen a case recover in which a compound depressed fracture of the skull occurring in the adult had been left without operation; but I have, on the other hand, seen several instances of recovery in which the bone had been elevated, and fragments removed.

The sooner this is done the better. Danger does not arise from early operation, but from delay. The presence of depressed and spiculated fragments pressing into

the dura mater must infallibly and speedily induce encephalitis. I have several times trephined under such circumstances as these with success, and have never had occasion to regret doing so. Indeed, there is no class of cases in which the operation of trephining is attended by such successful results as in those of depressed and comminuted fracture. Even though several days have elapsed and inflammation has set in, the proper treatment will be to remove the depressed and splintered bone, and thus give the patient his only chance—a slender one, it is true—of recovery. In such adverse circumstances the patient may, however, be saved.

A man was admitted under Liston with a long depressed fracture on the side of the head, produced by the blow of a brickbat; though no sign of compression existed, yet symptoms of cerebral inflammation were speedily set up, and Liston trephined him on the fourth day after the accident; the man, who was perfectly conscious, walking into the operating theatre. A considerable splintering of the inner table was found, the fragments of which were removed. The dura mater having been punctured by one of the spicula of bone, diffuse suppuration of the membranes of the brain set in, and the patient died in a few days. In this case, however, the necessity for early trephining was clearly indicated, notwithstanding the absence of any symptom of compression.

When a depressed fracture of the skull is *complicated with a fracture or other injury of the spinal column*, it is sometimes difficult to determine how much of the symptoms may be due to one accident, and what proportion to the other. In such a case as this, however, we should, I think, treat the depressed fracture irrespectively of the vertebral injury, thus giving the patient a chance of recovery, of prolongation of life, or, at least, of return of consciousness before death. A man was admitted under my care into the hospital, with depressed fracture of the left parietal bone, and injury of the cervical spine, the precise nature of which could not be accurately determined. He was in a state of complete coma and paralysis. I trephined the skull and elevated the depressed portion of bone; he recovered his consciousness to a great degree, but died in a few days, apparently from the injury to the spine. On examination after death, we found a fracture of the fifth cervical vertebra.

INJURIES OF THE CONTENTS OF THE CRANIUM.

Wounds of the Brain and its Membranes are frequent in injuries of the head, and constitute one of the most important complications of these accidents. The extent of injury inflicted upon the cerebral substance has wide limits, from slight laceration without exposure, to denudation of the brain, disintegration, and escape of large portions of its pulp.

Causes.—Injury to the brain may be occasioned in various ways. The simplest form is that, perhaps, which is not unfrequently met with in undepressed fracture of the skull, and sometimes happens without fracture, from simple concussion or commotion of the head; laceration of the cerebral substance occurring under the seat of injury, or more frequently at a distant or opposite point, by a kind of *contrecoup*. This *laceration of the brain by contrecoup* is by no means of unfrequent occurrence. I have seen many striking instances of it, and have found it to be one of the commonest causes of death in simple fracture of the skull.

Laceration of the brain by *contrecoup* is attended by much extravasation of blood; and after death the brain-substance is found mixed up with coagula, and forming a soft, pulpy, bloody mass. In most instances that I have seen, the anterior lobes have been thus contused, lacerated, and disorganized. This accident may occur without any fracture of the skull or external sign of serious injury, and usually results from falls upon the back or side of the head, often from an inconsiderable height, as when a person slips suddenly up in frosty weather and strikes his head on the pavement; the anterior portions of the hemispheres of the brain, or the parts opposite to that struck, will then be found in the condition just described.

The brain and its membranes are often lacerated by the *sharp spicula of a depressed fracture*, which may penetrate to a considerable depth in its substance. And, lastly, the injury may be occasioned by *foreign bodies*, such as bullets, traversing or lodging in the head; or by *stabs and punctures* through the thinner portions of the skull, especially the orbital plate of the frontal bone. In this way a piece of stick, tobacco-pipe, the point of a knife, or a scissor-blade, may puncture the anterior part of the brain.

Symptoms and Effects.—The symptoms and results of wound or laceration of the brain vary greatly, according to the age of the patient, the seat of injury, and other conditions, which cannot very readily be determined. If the injury implicate those portions of the nervous centre at the base of the brain, the integrity of which is necessary for the proper maintenance of the respiratory act, immediate death must necessarily ensue. If, however, portions of this organ that are less essential to life, as the anterior lobes and upper part of the hemispheres, be injured, but very slight symptoms may occur; and in some cases there is no positive indication by which this injury of the cerebral substance can be determined, except by its exposure and escape through the external wound. Hence it is, that even the worst injuries of the head are rarely immediately fatal, the patient being seldom killed outright, unless the medulla oblongata or pons be wounded. Children, especially, have been known to bear extensive injuries of the brain, and even the loss of a considerable quantity of cerebral matter, without any very serious effects, either immediate or remote; and it is by no means of uncommon occurrence to see them live several days with an extent of injury to the brain which would rapidly have proved fatal to an adult. Indeed, it may be stated generally that, the younger the patient, the greater the chance of recovery. So, also, the prognosis may be considered more favorable after injury of the brain in men of the laboring class, whose minds are but little exercised, than in persons of more cultivated intellect. Twitching of the muscles and epileptiform fits are commonly met with when the brain is lacerated; and these, complicating stertor, or alternating with it, indicate the nature of the mischief.

Foreign bodies even of large size and considerable weight have been lodged for a considerable time within the skull, in contact with the brain, without occasioning death. Thus Hennen states that he has seen five cases in which bullets were lodged within the skull, that did not prove immediately fatal. Dr. Cunningham relates the case of a boy who lived twenty-four days with the breech of a pistol, weighing nine drachms, lying on the tentorium, and resting against the occipital bone. Dr. O'Callaghan has recorded the remarkable case of an officer who lived for about seven years with the breech of a fowling piece, weighing three ounces, lodged in the forehead; the right hemisphere of the brain resting on the flat part, from which it was only separated by false membrane.[1]

From the great variety of effects produced by these injuries, it must be evident that there can be no one set of symptoms indicative of wound of the brain, provided there be no external wound through which the condition of the cerebral substance can be ascertained. In those cases in which this does not exist, we can at most only suspect laceration, if we find that the ordinary symptoms of compression or concussion are associated with signs that do not usually occur in those conditions when uncomplicated; such as contraction of one pupil, dilatation of the other, and perhaps an alternation of these states with twitchings of the limbs, hemiplegia of one side, or paralysis of an arm, and of the opposite leg, with perhaps involuntary spasmodic movements of the other members. In simple uncomplicated cerebral compression the pupils are always dilated. In laceration of the brain without compression they are contracted. When laceration and compression are conjoined, one may be dilated and the other contracted, or both will be dilated or contracted according as the symptoms of compression or of laceration predominate. These irregular symptoms, when accompanied by much coldness on the surface, slowness of pulse, and depression of vital power, may generally be looked upon as indicative of cerebral laceration. This effect of the cerebral lesion, whether it assume the form of paralysis or of convulsions, is always manifested on the side of the body opposite to that on which the injury to the brain exists. But not necessarily opposite to that on which the blow has been inflicted on the head. For the injury to the brain may by counterstroke be in that cerebral hemisphere which is opposite to the side of the head that has been struck. Thus, if a person struck on the right side of the head sustains a rupture of the middle meningeal artery, and has extravasation of blood on the right hemisphere of the brain, he will have hemiplegia on the left side, and *vice versâ*. But, if the blow that is inflicted on the right side were to give rise to extravasation by counter-stroke on the left side of the head, the paralysis would develop itself on the side that had been struck. So it is with convulsive movements; they will occur in the face, arms, and legs, on the side opposite to that on which the

[1] [See also Prof. Bigelow's remarkable case in *Am. Journ. Med. Science* for July, 1850.—A.]

brain has been injured, whether that injury be on the side struck from direct violence, or on the opposite side from counter-stroke. In this way the hemiplegia may occur on one side, and the convulsions on the other. A man was struck a violent blow on the *right* temple. He was seized with hemiplegia and facial paralysis on the *left* side, and with convulsive movements on the *right* side of the face, the *right* arm, and leg. He died a few days after the injury. On examination, we found a fissure of the right parietal bone, laceration of the middle meningeal artery, and a large clot pressing on the *right* side of the brain. Hence the hemiplegia on the *left* side of the body. There was laceration with disorganization of the middle lobe of the brain on the *left* side. Hence the convulsive movements of the *right* side of the face, body, and limbs.

Saccharine diabetes is an occasional consequence of injuries of the brain. A man 43 years of age was admitted into hospital under my care with paralysis, the result of a fall on the back of his head. On examining his urine, it was found to contain sugar in very large quantity. Previously to the accident, he had been perfectly healthy and robust; and, as the paralytic symptoms disappeared, the diabetic sugar gradually lessened in quantity, until it ceased entirely to be formed, and this notwithstanding the continued use of saccharine and amylaceous matter in the food. Claude Bernard has recorded some similar instances in illustration of the most interesting and curious physiological fact pointed out by him, that wound of the central portion of the medulla oblongata and irritation of the fourth ventricle of the brain in rabbits occasion saccharine diabetes, and indeed, that in the dog artificial traumatic diabetes may be induced by fracture of the skull and consecutive injury of the brain.

The *danger* of wounds of the brain varies greatly according to the part of the cerebral substance that is injured. It is greatest and most immediate in injuries of the base of the brain, of the pons, and crura cerebri; it is least and most remote when the upper and anterior part of the hemispheres is the seat of lesion.

The *mode of death* after these injuries also varies. They may prove fatal, either at once, when the base is wounded, by the injury of the respiratory tract; in the course of a few hours, by the continuance of shock, and by the extravasation of blood within the cranium; at a later period, by the occurrence of encephalitis and its consequences; or more remotely still, by the supervention of paralysis and other ulterior effects of injury of the nervous system.

The *cerebral nerves* are occasionally injured at their roots, or in their deeper connections torn across or detached from their connection with the brain in injuries of the head. These nerves may be wounded by the same violence that injures the brain, as when a bullet traverses the head; or they may be detached from their connection with the brain in laceration of the cerebral pulp; or, lastly, they may be torn across in fracture of the base of the skull by the fissure extending across the foramen through which the nerve passes.

Thus blindness may result from injury to the optic nerve at any part of its course; ptosis, and strabismus in different directions, according as the third, the fourth, or the sixth nerve has been injured. But the nerve that most commonly suffers is the seventh, which, either in its facial or in its auditory portion, is not uncommonly torn across in fractures of the petrous portion of the temporal bone, producing either paralysis of the face or deafness.

Injury to the eighth nerve is not common, or rather it is not common for patients long to survive who exhibit evidence of the lesion. I have, however, seen repeated vomitings, with palpitations, and a sense of suffocation continuing for months after apparent injury to the origins of the pneumogastric. In other cases, from lesion to the spinal accessory, spasm of the trapezius and sterno-mastoid muscles may set in.

Treatment.—In the treatment of injuries of the brain, little can be done after the system has rallied from the shock, beyond attention to strict antiphlogistic treatment, though this need not be of a very active kind. In these cases, indeed, as much should be left to nature as possible, the surgeon merely removing all sources of irritation and excitement from his patient, and applying simple local dressings.

If any foreign body be lodged within the skull, it must of course be removed, if possible. This may be done if it be situated near the external wound, or fixed in the bones; but if it have penetrated deeply into the substance of the brain, and

have passed beyond the limits of the external wound so as to have gone completely out of reach, it would be perhaps more dangerous to trephine the skull on the chance of reaching it, or in any other way to go in search of it, than to leave it where it is. Bullets should always be extracted if they can be found. On this point military surgeons are agreed. If they enter the skull, and strike against and fracture the opposite side without escaping, should they be sought for? I think not. Larrey and Bell, it is true, have extracted the ball on the side of the head opposite the point of entrance. But it may not be found there. In a case of suicide to which I was called some years ago, a gentleman had shot himself through the right temple; immediately opposite the wound, on the left temple, was a raised, loose and stellated fracture of the skull, over which the scalp was uninjured. I cut down on this and removed the fragments of bone, expecting to find the ball beneath them; but in this I was disappointed, and after death the bullet was found lying on the base of the skull, where it had rolled.

Fungus or Hernia Cerebri.—In those cases in which a laceration of the brain and dura mater communicates with a fracture of the skull, it is occasionally found, more particularly in children, that a dark brown or bloody fungous-looking mass of cerebral matter protrudes from the wound. The period after the receipt of an injury at which this protrusion takes place, varies from a few days—eight or ten—to several weeks. It has been remarked by Guthrie, and the observation has been fully confirmed, that hernia cerebri is more likely to take place through small than large apertures in the cranial bones. This tumor increases pretty rapidly, pulsates synchronously with the brain, and may shortly attain the size of a hen's egg, or even become larger. In its composition and structure it varies. In some instances it is composed chiefly, if not entirely, of extravasated blood; but the true fungus cerebri is composed of softened and disintegrated cerebral matter, infiltrated with lymph and blood. The softening of the brain, with red discoloration of its substance, extends for some little distance under the base of the tumor. The mental condition of the patient laboring under this affection is in many cases not much disturbed at first, there being merely some degree of cerebral irritation. Speedily, however, stupor comes on, and death eventually occurs from encephalitis, followed by coma, consequent on the inflammatory effusions that take place within the skull.

Treatment.—The treatment of this complication of fractures of the skull is commonly extremely unsatisfactory. If the tumor be shaved off, as usually recommended, it generally sprouts again until the patient is destroyed by irritation and coma conjoined. In some fortunate cases, however, the removal of the tumor is not followed by its reproduction. All that can be done is to slice off the growth on a level with the brain; to apply a pledget of wet lint, and a compress and bandage over the part, thus allowing it to granulate and the wound to cicatrize.

Extravasation of Blood within the Skull commonly occurs in all injuries of the head accompanied by laceration of the brain, and in many of those in which the skull is fractured without that organ being injured. Indeed, when we reflect on the great vascularity of the parts within the skull, the large sinuses, the numerous arteries that ramify both within the bones and at the base of the brain, and the close vascular network extended over the surface of this organ, we can easily understand that extravasation of blood is one of the most frequent complications of these injuries and a common cause of death, when they terminate fatally at an early period after their occurrence.

Causes.—Intracranial extravasation of blood may take place either with or without fracture of the skull. When it occurs as the result of fracture, it is in consequence of the fissure tearing across one of the meningeal arteries distributed on the inside of the skull, or of a fragment of bone wounding a sinus or the vascular network on the surface of the brain; or it may proceed from laceration of this organ breaking down its capillary structure. In other cases, again, as in gunshot wounds, the hemorrhage may occur as a consequence of wound of the vessels by the bullet or other foreign body; but it may also be the result of apparently trivial injuries of the head without bruise or wound of scalp, or fracture of skull, from the rupture by concussion of one of the meningeal arteries.

Situations.—The extravasations may occur in four situations: 1. Between the dura mater and the skull, where it is most commonly met with; 2. Within the cavity of the arachnoid; 3. Upon the surface of the brain; or, 4. Within its substance and

its ventricles. It is usually most considerable when poured out upon the dura mater, or within the cavity of the arachnoid at the base of the brain. It is in smallest quantity immediately on the surface of that organ, or within its substance. It is, however, seldom found in the latter situation as the result of violence, without being met with more superficially. The quantity effused in any one case seldom exceeds four ounces; and, when in such large quantity as this, it usually proceeds from rupture of the meningeal artery.

Results.—Extravasation of blood is one of the most frequent causes of death in injuries of the head, by inducing pressure on the brain and coma. The blood that is extravasated usually coagulates into a firm granular clot. There can be no doubt, however, that extravasation of blood into the membranes of the brain frequently occurs without being attended by fatal consequences. The blood that is so extravasated may undergo various changes. It would appear that, 1. The extravasated blood may be absorbed entirely; 2. The serous portions and coloring matter may be removed, leaving a fibrinous buff-colored clot, which may eventually become organized; and 3. The exterior of the clot may become consolidated, whilst the interior contains fluid and disintegrated blood.

Symptoms.—The symptoms of extravasation are often by no means very clear; being those of compression, associated in the early stages of the case with symptoms indicative of laceration of the brain, and at a later period, with those of encephalitis. Putting out of consideration, however, these complications, the more special symptoms of compression from extravasated blood may occur in two ways. In the first variety there are three distinct stages; viz., concussion, a return and some continuance of consciousness, and then coma gradually supervening. The patient is concussed or stunned as usual, after the receipt of a blow on the head; from this he quickly rallies, and then symptoms of compression set in, and gradually increase in intensity. He becomes drowsy and dull, with a slow and laboring pulse, dilated and sluggish pupils, and a tendency to slow respiration; as the compression increases, complete stupor at length comes on, with stertor in breathing, and there is either general paralysis, or hemiplegia of the side opposite to the seat of injury.

When the symptoms run this regular course, it is probable that the extravasation results from injury of one of the meningeal arteries or large venous sinuses; that the extravasation is confined to the membranes of the brain; and that there is no laceration of the substance of this organ. This may be termed the *meningeal extravasation;* it most commonly arises from rupture of the middle meningeal artery, which, from its situation in a deep canal in the parietal bone, is peculiarly apt to be torn in injuries of the side of the skull.

More commonly, however, it happens that the patient never recovers his consciousness after having been stunned, the symptoms of concussion speedily passing into those of compression. In these cases the paralysis is commonly incomplete, and is associated with twitchings of the limbs or convulsive movements of the body generally, and much restlessness with incoherent muttering: there is sometimes contraction, sometimes dilatation of the pupils, and it occasionally happens that squinting is observed. It is especially when there are convulsions, that the pupils are observed to be in different conditions; and I have most frequently noticed the pupil dilated on the side that is most convulsed. In these cases the extravasation is probably connected with and dependent on laceration or disorganization of a portion of the brain, and may consequently be termed the *cerebral extravasation.*

Diagnosis.—The diagnosis of these two forms of extravasation from one another is important, as it is in the meningeal only that any operative procedure can be successfully undertaken; and it may usually readily be effected by attention to the symptoms just detailed.

The diagnosis of the compression from *extravasation*, and from *depressed bone or inflammatory effusions within the skull*, is easily made. In the case of the depressed fracture, we have symptoms of compression continuing uninterruptedly from the very first, and proper examination of the skull will always lead to the detection of the injured bone. When inflammatory effusions, whether of pus, lymph, or serum, exercise undue pressure upon the brain, we find that the signs of compression have been preceded by symptoms of cerebral inflammation, and that they are accompanied by a good deal of pyrexia, by quick pulse and hot skin; the character of the scalp-wound likewise, and the separation of the dura mater when pus is effused, enable

us to distinguish this condition from those cases in which the pressure is the result of extravasated blood.

From *apoplexy*, the diagnosis is not always easily made, more particularly when there is no evidence that the head has been injured. A man was brought to University College Hospital in a state of profound coma, in which condition he had been found lying in the street. There was no evidence of injury about the head, beyond a bruise, which had probably been received when he fell. The case, which was supposed to be one of apoplexy, and treated accordingly, proved fatal in a few hours. On examination after death the skull was found fractured, but not depressed. On the opposite side to the bruise and fracture, a coagulum, weighing nearly four ounces and compressing the brain, lay between the dura mater and bone. In such a case as this, it is evident that the history can alone afford a clue to its true nature. Even when the head has been injured, it is not always easy. A man was admitted under my care, comatose. A fortnight previously, he had been struck on the left side of the head behind the ear. He was stunned, bled freely from the left ear, but then recovered tolerably, and went about his avocations as usual until the day before his admission, when he became suddenly comatose. There were stertor, quick pulse, and some heat of head; the right pupil was natural, the left contracted. He was treated antiphlogistically, but died on the third day. On examination, a fracture on the left side of the skull was found, extending into the left internal meatus; on the right side of the head, immediately opposite the fracture and the seat of injury, there was a large coagulum in the cavity of the arachnoid, with some serous exudation about it. Here was a meningeal extravasation, the result of *contrecoup*, existing without symptoms for fourteen days, and then proving rather suddenly fatal by the supervention of inflammation.

From the insensibility of *drunkenness*, the coma resulting from injuries of the head may usually be distinguished by the absence of local mischief, by the smell of the breath, and by the face of the drunkard being flushed and turgid, and not pale as in a person who is suffering from the effects of a severe injury. When a drunken person has met with an injury of the head and is insensible, he should always be carefully watched, however slight the injury may appear to be, until sufficient time has elapsed for him to recover from his drunken fit; as it is impossible to say whether the stupor be the result of intoxication, or of mischief within the skull; and I have known cases to be sent away from hospitals as drunk, when in reality the stupor was occasioned by depressed bone.

In the stupor from *poisoning by opium*, the condition of the pupils, which are contracted to the size of a pin's point, instead of being widely dilated as in coma from cerebral compression, will enable the surgeon to make the diagnosis.

The *treatment* of extravasation of blood may be conducted on two principles; either by means of general and local antiphlogistic measures, having for their object the arrest of further hemorrhage, the promotion of absorption, and the subdual of inflammatory action; or else by the application of the trephine, with the view of allowing the escape of the effused blood.

The line of treatment to be adopted should, I think, have reference to the character of the symptoms. When these indicate the *cerebral* form of extravasation, trephining can be of little service, and we must content ourselves with general antiphlogistics; but when the extravasation seems to be *meningeal*, then an attempt may be successfully made to evacuate the extravasated blood.

Although the operation of *trephining* in cases of extravasation was formerly much in vogue, it is seldom had recourse to by modern surgeons, and is only proper in the meningeal form of extravasation. It is very true that, if it can be ascertained without doubt that the extravasation is not only of the meningeal character, but that it is so situated that the blood may be removed through the trephine-aperture, and if there be no other serious injury to the brain or skull, the operation should at once be performed. And doubtless the case occasionally happens in which, from the situation of the blow, and perhaps the presence of a capillary fissure over the course of the middle meningeal artery, the gradual supervention of signs of compression after an interval of consciousness, and the occurrence of hemiplegia on the side opposite to that which has been struck, the surgeon is warranted in making an aperture in the skull at the seat of injury, in order to remove the blood that has been poured out, and to arrest its further effusion. But the instances in which this assemblage of symptoms could exist, with sufficient precision to justify an operation,

are excessively rare. Out of some hundred cases of serious and fatal injury of the head that have been admitted into University College Hospital during the last twenty years, in three cases only, I believe, has it been found advisable to have recourse to trephining for the removal of extravasated blood. In two of these cases death speedily ensued, the coma being unrelieved by the operation. In the third case, recovery took place. The successful case to which I refer was that of a man admitted comatose, three days after receiving an injury of the head by a fall from a cab. There were no serious symptoms for some hours after the accident; but then stupor gradually came on, amounting at last to complete coma. On examination, a bruise of the scalp was found on the left temple: through this I made an incision, and, finding a starred fracture over the sinus of the middle meningeal artery, trephined the bone, when a large coagulum was found lying upon the dura mater, and, on removing this, fluid arterial blood freely welled up. The coma was relieved by the operation, and the patient made a good recovery. The most serious objection to the application of the trephine in cases of extravasation does not, however, consist so much in the difficulty of determining that blood has been effused within the skull, or that the extravasation is of the meningeal form, as in the difficulty of diagnosing that it is so seated between the dura mater and the skull as to admit of removal; not being effused at the base, nor so widely coagulated over the surface of the brain as to be unable to escape through the aperture that may be made. The likelihood of the coexistence of fracture of the base of the skull and of laceration of the brain, giving rise to the cerebral form of extravasation, must also be taken into account. For these various reasons, surgeons now very properly content themselves, in the great majority of cases of extravasation, with the employment of antiphlogistic treatment, on the principles already stated. With this view the head should be shaved, the ice-bladder applied, the patient bled, purged, and kept at perfect rest. If, however, the signs be urgent, and pretty clearly indicate the meningeal form of extravasation, and more especially if there be hemiplegia on the side opposed to that on which the blow has been received, with an injury in the course of the middle meningeal artery, the trephine may be applied at the seat of injury and the blood removed. It must be borne in mind that, however clear the signs, the extravasation may not be met with where the surgeon expects to find it. In these circumstances, it is better not to prosecute the search by making fresh trephine apertures. In no case would a prudent surgeon trephine over the course of the middle meningeal artery in the absence of local symptoms, on the chance of finding the blood there, as has been recommended by some of the older surgeons.

Operation of Trephining.—Before concluding the subject of injuries of the head, it is necessary to say a few words on the operation of trephining, which, though far less commonly employed in the present day than heretofore, is one of sufficient frequency in practice, as well as of great importance from the serious nature of the cases that usually require it.

The trephine may be applied to the skull for two purposes; either with the view of preventing inflammation and its consequences, or for the purpose of removing some cause of compression. The only case in which *preventive* trephining is practised by modern surgeons, is that of the punctured or starred fracture of the skull, without stupor; in all other instances in which it is called for, the object of its application is the *removal* of a cause of compression or of irritation of the brain, such as a depressed portion of bone, foreign bodies either fixed in the skull or lying close under it, and pus or blood extravasated within the cranial cavity.

The trephine should have a well-tempered crown, serrated half way up its exterior; the teeth should be short and broad, and not too fine; the centre-pin must not project more than about the eighth of an inch, and care must be taken that the screw which fixes it is in good working order. The other instruments required are a Hey's saw, an elevator that will not readily snap, and a pair of strong dissecting forceps.

The operation itself should be conducted in the following way: The head having been shaved, and the portion of the skull to which the trephine is to be applied having been freely exposed by means of a crucial or T-shaped incision, or by the enlargement of any wound that may exist, the trephine, with the centre-pin protruded and well screwed down, is to be firmly applied until its teeth touch the skull; it is then worked with rather a sharp, light, and quick movement, the pressure being exercised as the hand is carried from left to right. The centre-pin must be

withdrawn so soon as a good groove is formed by the crown, lest it perforate the skull first and injure the dura mater. In this way the outer table of the skull is quickly divided, and the diploë cut into; the detritus which now rises by the crown of the trephine is soft and bloody, instead of being dry, as it is while the outer table is being sawn. As the instrument approaches the dura mater, the sawing must be conducted more warily, and must every now and then be interrupted, in order that the surgeon may examine with the flat end of a probe, or with a quill, the depth that has been obtained, care being taken that this is uniform throughout the circle. The surgeon now makes each turn very lightly, and now and then tries with a slight to-and-fro movement whether the circle of bone is loose. So soon as it is, he withdraws it in the crown of the trephine, or raises it out by means of the elevator. In this operation the dura mater must not be wounded; if it be injured, fatal consequences will probably ensue. The objects for which the trephining has been had recourse to must now be carried out, depressed bone being elevated or removed, and pus or blood evacuated. The scalp should then be laid down again, a few sutures and a piece of water-dressing being applied.

There are certain parts of the skull—over the venous sinuses, for instance, and near the base—to which no prudent surgeon would apply the instrument. So, also, if it were ever thought necessary to trephine at the frontal sinuses, the outer table must be first removed with a large crown, and the inner table sawn out with a smaller one.

After the operation, careful attention must be paid to antiphlogistic measures of a preventive and curative kind, the great direct danger to be apprehended being inflammation of the brain and its membranes. In some cases, also, there is reason to believe that suppurative phlebitis of the sinuses and veins of the diploë have been the cause of death.

The operation of trephining is by no means a favorable one in its results. Of 45 cases reported by Lente, as occurring at the New York Hospital (in which, however, there is no distinction made between the application of the trephine proper and of various instruments, such as the elevator, Hey's saw, &c., belonging to a trephining case), only 11, or about one-fourth recovered. Of 17 cases in which the trephine proper was used at University College Hospital, by Cooper, Liston, and myself, 6 patients recovered: 1 other died of injury of the spine unconnected with the operation, and the remaining 10 died from various causes. In the late American war, the results have been more satisfactory than the previous experience of army surgeons would have led us to hope. Of 117 cases of trephining, 47 recovered; and of 114 cases where fragments of bone were removed by the forceps and elevator, without the use of the trephine, 53 recovered. The Parisian surgeons have not been very successful. Nélaton says that all the cases of injury of the head, 16 in number, in which the trephine has been used in the Parisian hospitals during the last fifteen years, have terminated fatally.

But, although cases in which the trephine is used thus commonly terminate fatally, it would not be right to attribute the unfavorable result to the operation itself. In the majority of cases, death results from the injury sustained by the brain, from the pressure of extravasated blood at the base, or from encephalitis induced by the cerebral lesion, rather than from any direct influence exercised by the operation itself. And, as the cases to which modern surgeons now restrict the use of the trephine would necessarily prove fatal if left to themselves, it is but right to give the patient the slender chance of one to four of escaping with life.

[Although *trephining* is not of itself, perhaps, an extremely dangerous operation, it is always of necessity an additional injury inflicted on the patient. In cases of extensive comminution of the skull with external wound, it is almost always possible to remove loose fragments and elevate those which are depressed, though not detached, without trephining; and, in cases of impacted fracture, I believe it to be safer to allow the bone to remain depressed than to elevate it at the risk of converting a *subosseous* injury of the brain and meninges into one which is exposed to the atmosphere. I have seen well-marked and indeed typical symptoms of compression, in cases of compound depressed fracture of the skull pass off while the depression still remained, complete recovery following. With regard to trephining for the purpose of evacuating an abscess, in addition to the impossibility of knowing positively the situation of the abscess, or indeed whether the symptoms be not due to some other cause than the presence of pus, it must be borne in mind that cerebral

abscess, though probably always at last fatal, may exist for many years without even seriously incommoding the patient, and that recovery after trephining for this condition almost never occurs.

Bleeding is another remedy which is now very seldom employed in treating injuries of the head. On the contrary, most patients require nourishing food from the outset, and even free stimulation later in the progress of the case. *Opium* I have always been in the habit of giving freely in brain injuries, and with the best results. If the expression may be allowed, it "puts the brain in splints," and assists materially in producing that state of physiological rest which is the most important part of a true antiphlogistic course of treatment. *Dry cold* to the head, and *small doses of calomel* I have found of great service.

I have not found *erysipelas* more frequent after injuries of the head than after wounds of other parts of the body, and I am disposed to account for this (which would seem not to be the common experience) by the fact, that I do not prescribe the barley-water and "absolute diet" which is often recommended, but support patients so affected from the beginning, usually with milk in small quantities, frequently administered. When erysipelas has supervened, I have usually found it to disappear rapidly under free stimulation.—A.]

CHAPTER XXIII.

INJURIES OF THE SPINE.

Injuries of the spine, like those of the head, derive their importance from the degree to which the inclosed nervous centre is implicated.

The spinal cord is subject to *concussion*, *compression*, and *inflammation*, as the result of external violence; and any of those conditions may occur without injury to the osseous and ligamentous structures investing it, although, in the majority of cases, they are directly occasioned by fractures or dislocation of the vertebræ. It may also be *partially or completely divided* by cutting instruments, gunshot wounds, or broken vertebræ.

CONCUSSION OF THE SPINAL CORD.

It is by no means easy to give a clear and comprehensive definition of the term, concussion of the spinal cord. Without attempting to do so, it may be stated, that this phrase is generally adopted by surgeons to indicate a certain state of the cord occasioned by external violence; a state that is independent of, and usually, but not necessarily, uncomplicated with any obvious lesion of the vertebral column, such as its fracture or dislocation; a condition that is supposed to depend upon a shake or jar received by the cord, in consequence of which its intimate organic structure may be more or less deranged, and by which its functions are certainly greatly disturbed, various symptoms indicative of loss or modification of innervation being immediately or remotely induced.

In fact, it appears that surgeons and writers on diseases of the nervous system have included four distinct pathological conditions under this one term, concussion of the spinal cord: viz., 1. A jar or shake of the cord, disordering, to a greater or less degree, its functions, without any obvious lesion cognizable to the unaided eye; 2. Compression of the cord from extravasated blood; 3. Compression of the cord from inflammatory exudations within the spinal canal, whether of serum, lymph, or pus; and, 4. Chronic alterations of the structure of the cord, as the result of impairment of nutrition consequent on the occurrence of one or other of the preceding pathological states, but chiefly of the third. These various conditions differ remarkably from one another in symptoms and effects, and have only this in common, that they are not dependent upon an obvious external injury of the spine itself; in which respect they differ from the laceration or compression of the cord by the fracture with displacement or the dislocation of a vertebra.

Symptoms indicative of concussion of the spinal cord have of late years frequently occurred, in consequence of injuries sustained in railway collisions, and have been very forcibly brought under the observation of surgeons in consequence of their having been the fertile sources of litigation; actions for damages for injuries alleged to have been sustained in railway collisions having become of such very frequent occurrence as now to constitute a very important part of medico-legal inquiry. The symptoms arising from these accidents have been very variously interpreted by surgeons. Some practitioners have ignored them entirely, believing that they exist only in the imagination of the patient; or, if admitting their existence, have attributed them to other conditions of the nervous system than any that could arise from the alleged accident. And when their connection with, and dependence upon, an injury have been incontestably proved, no little discrepancy of opinion has arisen as to the ultimate result of the case, the permanence of the symptoms, and the curability of the patient. I cannot too strongly urge the fact that there is in reality nothing special in the symptoms of concussion of the spine produced by railway collisions, except in the severity of the accident by which the concussion was occasioned, and that it is consequently an error to look on a certain class of symptoms as special to railway accidents. Injuries received on railways may differ in their severity, but do not do so in their nature from injuries received in the other accidents of civil life. There is no more real difference between that concussion of the spine which results from a railway collision and that which is the consequence of a fall from a horse or a scaffold, than there is between a compound and comminuted fracture of the leg occasioned by the grinding of a railway carriage over the limb and that resulting from the passage of the wheel of a street cab across it. In either case, the injury arising from the railway accident will be essentially of the same nature as that which is otherwise occasioned; but it will probably be infinitely more severe and destructive in its effects, owing to the greater violence that occasions it.

Concussion of the spinal cord may be produced either by *direct violence*, as by severe blows or falls on the back, giving rise to local pain and signs of contusion, or by slight blows; or by *indirect violence*, as when a person meets with a general fall, jar, or concussion of the body, without any evidence of a blow having been inflicted on the spine itself.

Concussion from Direct Violence.—Concussion or commotion of the spinal cord, as a consequence of severe and direct blows upon the back, is an injury that has long been recognized and described by those writers who have occupied themselves with the consequences of accidents to this part of the body.

The *primary symptoms* of concussion of the cord immediately and directly produced by a severe blow upon the spine will necessarily vary in severity and extent according to the situation of the injury, the force with which it has been inflicted, and the amount of organic lesion that the delicate structure of the cord has sustained from the shock or jar to which it has been subjected. A severe blow upon the *upper cervical region* may produce instantaneous death. A less severe blow on this region may give rise to various phenomena, dependent on irritation of the large nerves that take their origin from the medulla oblongata. Thus, when the *vagus nerve* is affected, a sense of suffocation, with irregular action of the heart, may be experienced, or constant severe vomiting may be established, and may continue for months. Sometimes the *spinal accessory* is affected, and the trapezius or the sterno-mastoid muscle thrown into a more or less permanent spasmodic state. From irritation of the *phrenic nerve* hiccup and a peculiar sense of constriction round the body, as if the patient were girt by an iron band, may be established.

When the *lower part of the cervical spine* has been struck so as to concuss the cord, I have known paralysis of one or both arms induced, without any paralytic symptoms of the trunk or legs. In these cases the paralysis may go off entirely; or it may disappear in one arm and continue in another; or one nerve only may continue to be affected—such as the *circumflex*, the *musculo-spiral*, or the *ulnar*. There may be complete paralysis of sensation and of motion in any one of these nerves; or motor power may be lost, whilst sensation is normal; or, more commonly, where the sensibility continues, it is exalted, and we may find loss of motor power with hyperæsthesia. These modifications of innervation may be confined to one nerve, as the musculo-spiral, when there may be loss of motor power in the extensors and supinators of the forearm and hand, with loss of sensation or hyperæsthesia of the

skin of the hand supplied by the *radial* nerve. In other cases we find motor paralysis of the circumflex or musculo-spiral nerves, or hyperæsthesia of the ulnar. In these respects there is every possible variety. A severe blow inflicted on the *dorsal* or the *lumbar region* may induce more or less complete paraplegia. In some cases the paralysis of the lower limbs has been complete and instantaneous; and has affected both sensation and motion, with loss of power over the sphincters. In other cases there has only been paralysis of motion, sensation continuing perfect or being in excess. The reverse has been met with, but less frequently and less completely, there being loss of sensation, and impairment, though not complete loss of power over motion. One leg is frequently more severely affected than the other. Or the two legs may be unequally affected as to sensation and motion; both sensation and motion being impaired, but in varying degrees in the two limbs.

There may be complete loss of power over the sphincters both of the bladder and anus, with incontinence or retention of urine and feces; or the loss of power may be confined to the bladder only. This is especially the case when there is paralysis of motion rather than of sensation in the lower limbs.

The state of the urine will vary. If there be no retention, it will continue acid. When there is retention, the urine usually becomes alkaline, but sometimes, even when there is complete retention, it remains strongly acid; and Ollivier has noted the very remarkable circumstance in one case of retention, that there was an enormous formation of uric acid, so that the catheter became loaded with it.

Priapism does not occur in concussion, while it does so often in cases of laceration and irritation of the cord.

The *temperature* of the paralyzed parts is generally notably lower than that of the healthy parts of the body, and in some cases an absence of normal perspiration has been observed.

The *secondary symptoms* of severe concussion of the spine are usually those of the development of inflammation in the meninges and in the cord itself. They consist in *pain* in some part or parts of the spine, greatly increased by pressure and on motion, and consequent rigidity of the vertebral column, the patient moving it as a whole. The pain is greatly increased by all movements, but especially by those of rotation. It frequently extends down the limbs or round the body, giving the sensation of a cord tied tightly.

If the case go on to the development of acute inflammatory action in the cord and its membranes, *spasms* of a serious character come on; at first, usually of the nature of trismus; then general spasms of the body and limbs, usually followed by speedy death from the exhaustion produced by the repetition of these violent convulsive movements.

If the inflammation become chronic and subacute, permanent *alterations in the structure of the cord* will ensue, leading to incurable paralytic affections, usually confined to the lower extremities, but sometimes influencing the brain, and associated with great and deep-seated derangement of the general health.

White softening of the cord, unassociated with signs of inflammation of it or its membranes, may come on as the result of a blow on the back. In this condition paralysis of sensation or motion, often accompanied by peculiar rigidity of the muscles, may come on, and ultimately advance to general paralysis.

Causes of Death.—Concussion of the spinal cord from a severe and direct blow upon the back may prove fatal at very different periods, depending partly on the situation of the blow, and in a great measure on the lesions to which it has given rise. Sudden and fatal paralysis has often been incurred, without leaving after death any lesion of the cord that could be assigned as the cause of death. Abercrombie says, "Concussion of the cord may be speedily fatal without producing any morbid appearance that can be detected on dissection." And he refers to a case related by Boyer, and four recorded by Frank, in confirmation of this remark.

In other cases, however, the fatal result may be occasioned by direct and demonstrable lesion of the spine or cord. There appear to be three forms of lesion that will lead to a fatal result in cases of spinal concussion from direct severe violence.

1. Hemorrhage within the spinal canal may occur: *a.* Between the vertebræ and the dura mater; *b.* Between the membranes and the cord; *c.* In both situations. In these respects, intravertebral extravasations resemble closely those which occur as the result of injury within the cranium.

2. Laceration of the pia mater and hernia of the cord may be produced.

3. The injury may be followed by inflammation, with, perhaps, suppuration of the meninges, with inflammatory softening and disintegration of the substance of the cord. This is, doubtless, of an acute and probably inflammatory character.

Concussion of the spinal cord from a direct and severe injury of the back may also terminate in complete recovery after a longer or shorter time, or in incomplete recovery. The probability of the termination in recovery does not depend so much on the actual severity of the immediate symptoms that may have been occasioned by the accident, as on their persistence. If they continue beyond a certain time, changes will take place in the cord and its membranes which are incompatible with the proper exercise of its functions.

Injuries of the Vertebral Column in Concussion.—In concussion of the spinal cord, there is, in addition to the lesion of the cord, serious injury inflicted on the ligamentous and bony structures of the vertebral column. This injury, however, must be considered as an accidental complication, as it does not occasion, or even aggravate, the mischief done to the medulla. Thus the ligaments may be torn through so as to allow of partial separation of contiguous vertebræ; or, a vertebra may be fractured, but without any displacement of the broken fragments, or other sign by which it is possible during life to determine the exact amount of injury inflicted on the parts external to the cord. In this respect injuries of the spine closely resemble those of the head; their chief importance depending on the amount of injury inflicted upon the *contained* parts. In the spine, as in the head, it will sometimes be found after death from what appears to be, and in reality is, simple injury of the nervous centres, that the vertebral column in the one case, and the skull in the other, have suffered an amount of injury that was unsuspected during life; and which, though it may not in any way have determined the fatality of the result, yet affords conclusive evidence of the violence to which the parts have been subjected, and the intensity of the disorganizing shock that they have suffered.

There is, however, a very essential difference between the spine and the head. A simple fracture of the cranium may be of no moment, except so far as the violence that has occasioned it may have influenced the brain. In the spine, the case is not parallel; for, as the vertebral column is the centre of support to the body, its influence in this respect will be lost when it is broken; even though the spinal cord may not have been injured by the edges of the fractured vertebræ, but simply violently and fatally concussed by the same force that broke the spine.

Boyer noticed the very interesting practical fact, that, when the interspinous ligaments were ruptured in consequence of forcible flexion of the spine forwards, no fatal consequences usually ensued, the integrity of the parts being restored by rest; but that, when the ligamenta subflava were torn through and the arches separated, paraplegia and death followed. This he attributed to stretching of the spinal cord. Sir C. Bell, however, with great acuteness, has pointed out the error of this explanation, and states that "it is the progress of the inflammation to the spinal marrow, and not the pressure or the extension of it, which makes these cases of subluxation and breach of the tube fatal." There can be no doubt that this explanation is the correct one; and that, when once the spinal canal is forcibly torn open, fatal inflammation will spread to the meninges and to the medulla itself.

Effects of Slight Blows.—The consideration of the effects that may be produced on the spinal cord by *slight blows*, whether applied to the back or to a distant part of the body, has long arrested the attention of observant practitioners. Abercrombie, writing in 1829, says, that chronic inflammation of the cord and its membranes "may supervene upon very slight injuries of the spine." He says also, "Every injury of the spine should be considered as deserving of minute attention. The more immediate cause of anxiety in such cases is inflammatory action, which may be of an acute or chronic kind; and we have seen that it may advance in a very insidious manner even after injuries that were of so slight a kind that they attracted at the time little or no attention." Nothing can be clearer and more positive than this statement. These remarks of Abercrombie are confirmed by Ollivier, by Bell, and by other writers on such injuries.

Concussion from Indirect Violence.—There is a class of cases of an extremely insidious and protracted character; in which the patient has received no blow or injury upon the head or spine, but the whole system has had a severe shake or shock, in consequence of which disease is developed in the spinal cord, perhaps eventually extending to the membranes of the brain. These cases are more fre-

quently met with in railway than in other injuries; but they occasionally occur in consequence of ordinary accidents.

One of the most remarkable circumstances connected with injuries of the spinal cord is, the disproportion between the accident and the mischief produced thereby. Not only do most serious, progressive, and persistent symptoms of concussion of the spinal cord often develop themselves after apparently slight injuries, but frequently when there is no sign whatever of external injury. The shake or jar that is inflicted on the spine when a person jumping from the height of a few feet comes to the ground suddenly and heavily on his heels or in a sitting posture, has been well known to surgeons as a not uncommon cause of spinal weakness and debility. It is the same in railway accidents; the shock to which the patient is subjected in them being often followed by a train of slowly progressive symptoms, indicative of concussion and subsequent irritation and inflammation of the cord and its membranes.

It is worthy of remark, that the symptoms of spinal concussion seldom occur when a serious injury has been inflicted on one of the limbs, unless the spine itself have at the same time been severely and directly struck. A person who, by any ordinary accident, has one of his limbs fractured or dislocated, necessarily sustains a very severe shock; but it is extremely rare to find that the spinal cord or the brain has been injuriously influenced. It would appear as if the violence of the shock expended itself in the production of the fracture or the dislocation, and that a jar of the more delicate nervous structures is thus avoided. A familiar illustration of this is afforded in the injury sustained by a watch by falling on the ground. A watchmaker once told me that, if the glass were broken, the works were rarely damaged; if the glass escaped unbroken, the jar of the fall will usually be found to have stopped the movement.

How these jars, shakes, shocks, or concussions of the spinal cord directly influence its action, I cannot say with certainty. When a magnet is struck a heavy blow with a hammer, the magnetic force is jarred, shaken, or concussed out of the iron. So, if the spine be badly jarred, shaken, or concussed by a blow or shock of any kind communicated to the body, we find that the nervous force is to a certain extent shaken out of the man, and that he has in some way lost nervous power. What immediate change, if any, has taken place in the nervous structure to occasion that effect, we no more know than what change happens to a magnet when struck.

Secondary Effects.—Whatever may be the nature of the primary change that is produced in the spinal cord by a concussion, the secondary effects are clearly inflammatory, and are identical with those phenomena that have been described by Ollivier, Abercrombie, and others, as dependent on chronic meningitis of the cord, and subacute myelitis.

One of the most remarkable phenomena attendant upon this class of cases is, that at the time of the occurrence of the injury the sufferer is usually quite unconscious that any serious accident has happened to him.

There is great variation in the period at which the more serious, persistent, and positive symptoms of spinal lesion begin to develop themselves. In some cases they do so immediately after the occurrence of the injury, in others not until several weeks, perhaps even months, have elapsed. But during the whole of this interval, whether it be of short or of long duration, the sufferer's condition, mentally and bodily, has undergone a change. His friends remark, and he feels, that "he is not the man he was." He has lost bodily energy, mental capacity, and business aptitude. He looks ill and worn; often becomes irritable and easily fatigued. He still believes that he has sustained no serious or permanent hurt, tries to return to his business, finds that he cannot apply himself to it, takes rest, seeks change of air and scene, undergoes medical treatment of various kinds, but finds all of no avail. His symptoms become progressively more and more confirmed, and at last he resigns himself to the conviction that he has sustained a more serious bodily injury than he had at first believed, and one that has, in some way or other, broken down his nervous power, and has wrought the change of converting a man of mental energy and of active business habits into a valetudinarian, utterly unable to attend to the ordinary duties of life.

The *countenance* is usually pallid, livid, and has a peculiarly care-worn anxious expression; the patient generally looking much older than he really is, or than he did before the accident. I have seen one instance of flushing of the face.

The *thoughts* are confused. The patient cannot concentrate his ideas so as to carry out a connected line of argument; he attempts to read, but is obliged to lay aside the book or paper after a few minutes' attempt at perusal. All *business aptitude* is lost; partly from impairment of memory, partly from confusion of thought and inability to concentrate ideas for a sufficient length of time. The *temper* often becomes changed for the worse, the patient being fretful, irritable, and in some way —difficult perhaps to define, but easily appreciated by those around him—altered in character.

The *sleep* is disturbed, restless, and broken. He wakes up in sudden alarm; dreams much; the dreams are distressing and horrible.

The *head* is usually of its natural temperature, but sometimes hot. The patient complains of very uneasy sensations in it; of pain, tension, weight, or throbbing; of giddiness; of a confused or strained feeling in it; and frequently of loud and incessant noises, described as roaring, rushing, ringing, singing, sawing, rumbling, or thundering. These noises vary in intensity, at different periods of the day; but, if once they occur, they are never entirely absent, and are a source of great distress.

The *organs of special sense* usually become more or less seriously affected. They become sometimes over-sensitive and irritable, or their functions are impaired or perverted. In many cases we find a combination of all those conditions in the same organ. *Vision* is usually affected in various ways and in very different degrees. In some cases, though rarely, there is double vision, and perhaps slight strabismus. In others there is an alteration in the focal length, so that the patient has to use glasses, or to change those he has previously worn. The patient cannot read for more than a few minutes, the letters running into one another. More commonly, muscæ volitantes and spectra, rings, stars, flashes, or sparks—white, colored, or flame-like—are complained of. The eyes often become over-sensitive to light; and this intolerance of light may amount to positive photophobia. It gives rise to a habitually contracted state of the brows, so as to exclude light as much as possible from the eyes. One or both eyes may be thus affected. This intolerance of light may be associated with dimness and imperfection of sight. Vision may be normal in one eye, but impaired seriously in the other. The circulation in the bottom of the eye is visible to some patients. The *hearing* may be variously affected. Not only does the patient commonly complain of the noises in the head and ears that have already been described, but the ears, like the eyes, may be over-sensitive or too dull. One ear is frequently over-sensitive, whilst the other is less acute than it was before the accident. The relative sensibility of the ears may readily be measured by the distance at which the tick of a watch may be heard. Loud and sudden noises are peculiarly distressing to these patients. *Taste* and *smell* are sometimes, but more rarely, perverted.

The *sense of touch* is impaired. The patient cannot pick up a pin, cannot button his dress, cannot feel the difference between different textures, as cloth and velvet. He loses the sense of *weight*, and cannot tell, for instance, whether a sovereign or a shilling is balanced on his finger. *Speech* is rarely affected. The *attitude* is stiff and unbending. The patient holds himself very erect, usually walks straight forwards, as if afraid or unable to turn to either side. The *movements of the head or trunk*, or both, do not possess their natural freedom. There may be pain or difficulty in moving the head in the antero-posterior direction, or in rotating it; or all movements may be attended by so much pain and difficulty that the patient is afraid to attempt them, and hence keeps the head in an attitude of immobility. The movements of the trunk are often equally restrained, especially in the lumbar region. Flexion forwards, backwards, or sideways, is painful, difficult, and may be impossible; flexion backwards is usually most complained of. If the patient be desired to stoop and pick anything off the ground, he will not be able to do so in the usual way, but bends down on the knee and so reaches the ground. If he be laid horizontally, and told to raise himself into the sitting posture, without the use of his hands, he will be unable to do it.

The *state of the spine* will be found to be the real cause of these symptoms. On examining it by pressure, by percussion, or by the application of the hot sponge, it will be found that it is painful, and that its sensibility is exalted at one, two, or three points. These are usually the upper cervical, the middle dorsal, and the lumbar regions. The exact vertebræ that are affected vary necessarily in different

cases; but the exalted sensibility always includes two, and usually three at each of these points. It is in consequence of the pain that is occasioned by any movement of the trunk in the way of flexion or rotation, that the spine loses its natural suppleness, and that the vertebral column moves as a whole, as if cut out of one solid piece, instead of with its usual flexibility.

The *movements of the head upon the upper cervical vertebræ* are variously affected. In some cases the head moves freely in all directions, without pain or stiffness. In other cases, the greatest agony is induced if the surgeon take the head between his hands and bend it forwards or rotate it; the articulations between the occipital bone, the atlas, and the axis, being evidently in a state of inflammatory irritation. The pain is usually confined to the vertebral column, and does not extend beyond the transverse processes. But, in some instances, the pain extends widely over the back on both sides, and seems to correspond with the distribution of the posterior branches of the dorsal nerves. In these cases, from the musculo-cutaneous distribution of these nerves, the pain is superficial and cutaneous as well as deeply seated.

The *muscles of the back* are usually unaffected; but in some cases, where the muscular branches of the dorsal nerves are affected, they may become very irritable and spasmodically contracted, so that their outlines are very distinct and marked.

The *gait* of the patient is characteristic. He walks more or less unsteadily, generally uses a stick, or if deprived of that, is apt to lay his hand on any article of furniture that is near to him, with the view of steadying himself. He keeps his feet somewhat apart, so as to increase the basis of support, and consequently walks in a straddling manner. As one leg is often weaker than the other, he totters somewhat, and raises one foot but slightly off the ground, so that the heel is apt to touch. He seldom drags the toe; but, as he walks flat-footed as it were one side, the heel drags. This peculiar straddling, tottering, unsteady gait, with the spine rigid, the head erect, and looking straight forwards, gives the patient the aspect of a man who walks blindfolded. The patient cannot generally stand equally well on either foot. One leg usually immediately gives way under him if he attempt to stand on it. He often cannot raise himself on his toes, or stand on them, without immediately tottering forwards. His power of walking is always very limited; it seldom exceeds half a mile or a mile at the utmost. He cannot ride, even if much in the habit of doing so before the accident. There is usually considerable difficulty in going up and down stairs—more difficulty in going down than up. The patient is obliged to support himself by holding on to the banisters, and often brings both feet together on the same step.

A *sensation as of a cord tied round the waist*, with occasional spasm of the diaphragm, giving rise to a catch in the breathing, or hiccup, is sometimes met with, and is very distressing when it does occur.

The *nervous power of the limbs* will be found to be variously modified, and will generally be so to very different degrees in the different limbs. Sometimes one limb only is affected; in other cases the arm and leg on one side, or both legs only, or the arm and both legs, or all four limbs, are the seat of uneasy sensations. There is the greatest possible variety in these respects, dependent of course entirely upon the degree and extent of the lesion that has been inflicted upon or induced in the spinal cord. Sensation or motion only may be affected; or both may be affected, either alike or in unequal degrees. Sensation and motion may be both seriously impaired in one limb, or sensation in one and motion in another. The paralysis is seldom complete. It may become so in the more advanced stages, after several years; but for the first year or two it is almost always partial. It is sometimes incompletely recovered from, especially so far as sensation is concerned.

The *loss of motor power* is especially marked in the legs, and more often in the extensor than in the flexor muscles. The extensor of the great toe is especially apt to suffer. The hand and arm are less frequently the seat of loss of motor power than the leg and foot; but the muscles of the ball of the thumb, or the flexors of the fingers, may be affected.

The loss of motor power in the foot and leg is best tested by the application of the galvanic current, so as to compare the irritability of the same muscles of the opposite limbs. The electric test is not under the influence of the patient's will; and a very true estimate can thus be made of the loss of contractility in any given set of muscles.

The loss of motor power in the hand is best tested by the force of the patient's grasp. This may be roughly estimated by telling him to squeeze the surgeon's fingers, first with one hand and then with the other, or more accurately by means of the dynamometer which shows on an index the precise amount of pressure exercised in grasping.

It is in consequence of the diminution of motor power in the legs that those peculiarities of gait which have been above described are met with, and they are most marked when the amount of loss is unequal in the two limbs.

Modification or diminution of sensation in the limbs is one of the most marked phenomena in these cases. In many instances the sensibility is a good deal augmented, especially in the earlier stages. The patient complains of shooting pains down the limbs, like stabs, darts, or electrical shocks. The surface of the skin is sometimes over-sensitive in places on the back; or, in various parts of the limbs, hot, burning sensations are experienced. After a time these sensations give place to various others, which are very differently described by patients. Tinglings, a feeling of "pins and needles," a heavy sensation, as if the limb were asleep, creeping sensations down the back and along the nerves, and formications, are all commonly complained of. These sensations are often confined to one nerve in a limb, as the ulnar or the musculo-spiral. Numbness, more or less complete, may exist independently of, or be associated with, all these various modifications of sensation. It may be confined to a part of a limb, may influence the whole of it, or may extend to several limbs. Its degree and extent are best tested by Brown-Séquard's instrument.

Coldness of one of the extremities, dependent upon loss of nervous power and defective nutrition, is often perceptible to the touch, and may be determined by the thermometer; but in many cases the sensation of coldness is far greater to the patient than it is to the surgeon's hand, and not unfrequently no appreciable difference in the temperature of two limbs can be determined by the most delicate clinical thermometer, although the patient experiences a very distinct and distressing sense of coldness in one limb.

The condition of the limbs as to *size*, and the *state of their muscles*, will vary greatly.

In some cases of complete paraplegia, which has lasted for years, it has been remarked that no diminution whatever has taken place in the size of the limbs. It is evident, therefore, that loss of size in a limb that is more or less completely paralyzed is not the simple consequence of the disuse of the muscles; or it would always occur. But it must arise from some modification of innervation, influencing the nutrition of the limb, independently of the loss of its muscular activity. In most cases, however, where the paralytic condition has been of some duration, the limb, on accurate measurement, will be found to be somewhat smaller in circumference than its fellow on the opposite side.

Most commonly when a limb dwindles the muscles become soft, and the intermuscular spaces more distinct. Occasionally, in advanced cases, a certain degree of contraction and of rigidity in particular muscles sets in. Thus the flexors of the little and ring fingers, the extensors of the great toe, the deltoid or the muscles of the calf, may all become the seats of more or less rigidity and contraction.

The *body* itself generally loses weight; and a loss of weight, when the patient is rendered inactive by a semi-paralyzed state, and takes a fair quantity of good food, which he digests sufficiently well, may usually be taken to be indicative of progressive disease in the nervous system. When the progress of the disease has been arrested, though the patient may be permanently paralyzed, a considerable increase of size and weight often takes place. This is a phenomenon of common occurrence in ordinary cases of paralysis from disease of the brain.

The condition of the *genito-urinary* organs is seldom much deranged in the cases under consideration. Retention of urine very rarely occurs. Sometimes irritability of the bladder is a prominent symptom. The urine generally retains its acidity, sometimes markedly, at others but very slightly so. As there is no retention, it does not become alkaline, ammoniacal, or otherwise offensive.

The sexual desire and power are usually greatly impaired, and often entirely lost; not invariably so, however. I have never heard priapism complained of.

The contractility of the *sphincter ani* has not, in any case which I have observed, been so far impaired as to lead to involuntary escape of flatus or of feces.

The *pulse* varies in frequency at different periods. In the early stages it is usually slow; in the more advanced it is quick, near to or above 100. It is always feeble.

The progressive development of the various symptoms that have just been detailed usually extends over a lengthened period. In the early stages, the chief complaint is a sensation of lassitude, weariness, and inability for mental and physical exertion. Then come the pains, tinglings, and numbness of the limbs; next the fixed pain and rigidity of the spine; then the mental confusion and signs of cerebral disturbance, and the affection of the organs of sense; the loss of motor power, and the peculiarity of gait.

The period of the supervention of these symptoms after the occurrence of the injury will vary greatly. Most commonly, after the first and immediate effects of the accident have passed off, there is a period of comparative ease, and of remission of the symptoms, during which the patient imagines that he will speedily regain his health and strength. This period may last for many weeks, possibly for two or three months. At this time there will be considerable fluctuation in the patient's state. So long as he is at rest, he will feel tolerably well; but any attempt at ordinary exertion of body or mind brings back all the feelings or indications of nervous prostration and irritation characteristic of these injuries; and to these will gradually be superadded the more serious symptoms which evidently proceed from a chronic disease of the cord and its membranes. After a lapse of several months —from three to six—the patient will find that he is slowly but steadily becoming worse, and he then, perhaps for the first time, becomes aware of the serious and deep-seated injury that his nervous system has sustained.

Although there is often this long interval between the time of the occurrence of the accident and the supervention of the more distressing symptoms, it will be found, on close inquiry, *that there has never been an interval of complete restoration to health.* The patient has thought himself and has felt himself much better at one period than he was at another; so much so, that he has been tempted to try to return to his usual occupation; but he has never felt himself well, and has immediately relapsed to a worse state than before when he has attempted to do work of any kind.

It is by this chain of symptoms, which, though fluctuating in intensity, is yet continuous and unbroken, that the injury sustained, and the illness subsequently developed, can be linked together in the relation of cause and effect.

Pathological Conditions.—Two distinct forms of chronic and subacute inflammation may affect the contents of the spinal canal, as the results of injury or of disease; viz., inflammation of the membranes, and inflammation of the cord itself.

In *spinal meningitis*, the usual signs of inflammatory action in the form of vascularization of the membranes is met with. The meningo-rachidian veins are turgid with blood, and the vessels of the pia mater will be found much injected, sometimes in patches, at other times uniformly. Serous fluid, reddened and clear, or opaque from the admixture of lymph, may be found largely effused in the cavity of the arachnoid.

In distinguishing the various pathological appearances presented by fatal cases of chronic spinal meningitis, Ollivier makes the very important remark that spinal meningitis rarely exists without there being at the same time a more or less extensive inflammation of the cerebral meninges; and hence, he says, arises the difficulty of determining with precision the symptoms that are special to inflammation of the membranes of the spinal cord.

When myelitis occurs, the inflammation attacking the substance of the cord itself, the most usual pathological condition met with is softening of its substance, with more or less disorganization. This softening of the cord, as a consequence of inflammation, may occupy very varying extents. Sometimes the whole thickness of the cord is affected at one point, sometimes one of the lateral halves in a vertical direction; at other times the disease is most marked in or wholly confined to its anterior or its posterior aspect; or the gray central portion may be more affected than the circumferential part. Again, these changes of structure may be limited to one part only, to the cervical, the dorsal, or the lumbar. It is very rare indeed that the whole length of the cord is affected. The most common seat of inflammatory softening is the lumbar region; next in order of frequency the cervical. In

very chronic cases of myelitis, the whole of the nervous substance disappears, and nothing but connective tissue is left at the part affected.

Ollivier observes that, when myelitis is consecutive to meningitis of the cord, the inflammatory softening may be confined to the white substance.

Though softening is the ordinary change that takes place in a cord that has been the seat of chronic inflammation, sometimes the nervous substance becomes increased in bulk, more solid than natural, and of a dull white color, like boiled white of egg. This induration of the cord may coexist with spinal meningitis, with congestion, and increased vascularization of the membranes.

It is important to observe that, although spinal meningitis and myelitis are occasionally met with distinct and separate, yet they most frequently coexist. When existing together, and even arising from the same cause, they may be associated in very varying degrees. In some cases the symptoms of meningitis, in others those of myelitis, are most marked; and, after death, corresponding characteristic appearances are found.

Diagnosis.—There are three morbid states for one or other of which I have known the symptoms of spinal concussion, which have been just described, to be confounded, and from which it is necessary to diagnose it. These are, 1. The secondary consequences of cerebral concussion; 2. Rheumatism; and 3. Hysteria.

1. From the *secondary effects of cerebral concussion* it is not difficult to diagnose the consequences of concussion of the spinal cord, in those cases in which the mischief is limited to the vertebral column. The tenderness and rigidity of the spine, the pain on pressing upon or on moving it in any direction, and the absence of any distinct lesion about the head, will sufficiently mark the precise situation of the injury.

The two conditions of cerebral and spinal concussion often coexist primarily. The shock that jars injuriously one portion of the nervous system, very commonly produces a corresponding effect on the whole of it, on the brain as well as on the cord; and the secondary inflammations of the spine, which follow the concussion, even when that is primarily limited to the vertebral column and its contents, have a tendency to extend along the continuous fibrous and serous membranes to the interior of the cranium, and thus to give rise to symptoms of cerebral irritation.

2. From *rheumatism* the diagnosis may not always be easy, especially in the earlier stages of the disease, when the concussion of the spine and the consecutive meningitis have developed pain along the course of the nerves, and increased cutaneous sensibility at points. By attention, however, to the history of the case, the slow but gradually progressive character of the symptoms of spinal concussion, the absence of all fixed pain except at one or more points in the back, the cerebral complications, the gradual occurrence of loss of sensibility, of tinglings and formications, the slow supervention of impairment or loss of motor power in certain sets of muscles (symptoms that do not occur in rheumatism), the diagnosis will be rendered comparatively easy; the more so, when we observe that in spinal concussion there is never any concomitant articular inflammation, and that, although the urine may continue acid, it does not usually present evidences of a superabundance of lithates.

3. *Hysteria* is the disease for which I have more frequently seen concussion of the spine, followed by meningo-myelitis, mistaken; and it has always appeared extraordinary to me that so great an error of diagnosis could easily be made. Hysteria, whether in its emotional or its local form, is a disease of women rather than of men, of the young rather than of the middle-aged and old, of people of an excitable, imaginative, or emotional disposition rather than of hard-headed, active, practical men of business. It is a disease that runs no definite or progressive course, that assumes no permanence of action, that is ever varying in the intensity, in the degree, and in the nature of its symptoms; that is marked by excessive and violent outbreaks of an emotional character, or by severe exacerbations of its local symptoms, but that is equally characterized by long-continued and complete intermissions of its various phenomena. This in no way resembles what we see in concussion of the spinal cord, or in the consecutive meningo-myelitis; and it seems to me quite unreasonable to call a case one of hysteria in which a man active in mind, accustomed to self-control, addicted to business, suddenly, and for the first time in his life, after the infliction of a severe shock, finds himself affected by a train of symptoms indicative of serious and deep-seated injury to the nervous system.

In reality, there can be but little difficulty in establishing the diagnosis between chronic meningo-myelitis and hysteria. The persistence of the symptoms, their slow development, their progressive increase in severity, notwithstanding occasional fluctuations and intermissions in intensity, the invariable presence of more or less paralysis of sensation, or of motion, or both, will easily enable the surgeon to judge of the true nature of the case. That mental emotion is occasionally manifested by an unfortunate individual who has been seriously injured by an accident which tends to shake his whole nervous system, can scarcely be matter of surprise; but the term "hysteria," elastic as it is, cannot, it appears to me, be strained so far as to denote this condition; and even if it be considered applicable to the patient's mental state, it can in no way be looked upon as the cause of those bodily sufferings and disabilities which constitute the most important and serious part of his disease.

Prognosis of Spinal Concussion.—The prognosis of concussion of the spinal cord and that of the consecutive meningo-myelitis is a question of extreme interest in a medico-legal point of view, and is often involved in no little difficulty.

The prognosis requires to be made with regard, first to the life, and secondly to the health of the patient. So far as life is concerned, it is only in those cases of severe and direct blows upon the spine, in which intraspinal hemorrhage to a considerable extent has occurred, or in which the cord or its membranes have been ruptured, that a speedily fatal termination may be feared.

In some of the cases of concussion of the spine, followed by chronic inflammation of the membranes and of the cord itself, death may eventually supervene after several, perhaps three or four, years of an increasingly progressive breaking down of the general health, and the slow extension of the paralytic symptoms. I have heard of several instances in which concussion of the spine has thus proved fatal some years after the occurrence of the accident.

I have never known a patient recover who has been afflicted by convulsions, progressive paralysis developing itself, and the case ultimately proving fatal. Mr. Gore, of Bath, informs me that he is acquainted with two cases which proved fatal at long periods of time after the accident, in both of which this symptom was present. Concussion of the spine may prove fatal: first, at an early period by the severity of the direct injury; secondly, at a more remote date by the occurrence of inflammation of the cord and its membranes; and, thirdly, after a lapse of several years, by the slow and progressive development of structural changes in the cord and its membranes.

But though death may not occur, is recovery certain? Is there no mid state between a fatal result, proximate or remote, and the absolute and complete recovery of the patient?

In considering the question of recovery after concussion of the spine, we have to look to two points: first, the recovery from the primary and direct effects of the injury; and, secondly, the recovery from the secondary and remote consequences. There can be no doubt that recovery, entire and complete, may occur in a case of concussion of the spine, when the symptoms have not gone beyond the primary stage, when no inflammatory action of the cord or its membranes has been developed, and most particularly when the patient is young and healthy in constitution. This last condition indeed is a most important one. A young man of healthy organization is not only less likely to suffer from a severe shock to the system from a fall or railway injury than one more advanced in life; but, if he do suffer, his chance of ultimate recovery will be greater, provided always that no secondary and organic lesions have developed themselves. I believe that such recovery is more likely to ensue if the primary and direct symptoms have been severe, and have at or almost immediately after the occurrence of the accident attained to their full intensity. In these cases, under proper treatment the severity of the symptoms gradually subsides, and, week by week, the patient feels himself stronger and better, until, usually in from three to six months at the utmost, all traces of the injury have disappeared.

Incomplete or partial recovery is not unfrequent in cases of severe and direct injury of the spine. The patient slowly recovers up to a certain point and then remains stationary, with some impairment of innervation in the shape of partial paralysis of sensation, or of motion, or both, usually in the lower limbs. The intellectual faculties or the organs of sense are more or less disturbed, weakened, or irritated, the constitution is shattered, and the patient presents a prematurely

worn and aged look. In such cases structural lesion of some kind, in the membranes, if not in the cord, has taken place, which necessarily must prevent complete recovery.

When, therefore, we find a patient who, after the receipt of a severe injury of the spine by which the cord has been concussed, presents the primary and immediate symptoms of that condition, we may entertain a favorable opinion of his future condition, provided there be a progressive amelioration of his symptoms, and no evidence of the development of any inflammation, acute or chronic, of the membranes and the cord. But our opinion as to his ultimate recovery must necessarily be very unfavorable if we find the progress of amendment cease after some weeks or months, leaving a state of impaired innervation. And this unfavorable opinion will be much strengthened if, subsequently to the primary and immediate effect of the injury, symptoms of meningo-myelitis have declared themselves. In such circumstances partial restoration to health may be looked for, but complete recovery is not possible.

When a person has received a concussion of the spinal cord from a jar or shake of the body, without any direct blow on the back, or perhaps on any other part of the body, and the symptoms have gradually and progressively developed themselves, the prognosis will always be very unfavorable; for this reason, that, as the injury is not sufficient of itself to produce a direct and immediate lesion of the cord, any symptoms that develop themselves must be the result of structural changes taking place in it as the consequence of its inflammation; and these secondary structural changes, being incurable, must, to a greater or less degree, but permanently, injuriously influence its action. The occurrence of a lengthened interval, a period of several weeks, for instance, between the infliction of the injury and the development of the spinal symptoms, is peculiarly unfavorable, as it indicates that a slow and progressive structural change has been taking place in the cord and its membranes, dependent upon pathological changes of a deep-seated and permanently incurable character.

In forming an opinion as to the patient's probable future state, I believe that it is of less importance to look to the immediate or early severity of the symptoms than to their slow, progressive and insidious development. Those cases are least likely to recover in which the symptoms affect the latter course.

The time that the symptoms have lasted is necessarily a most important matter for consideration. When they have been of but short duration, they may possibly be dependent on conditions that are completely, and perhaps easily, removable by proper treatment; as, for instance, on extravasation of blood, or on acute serous inflammatory effusion. But when the symptoms, however slight they may be, have continued even without progressive increase, but have merely remained stationary for a lengthened period of many months, they will undoubtedly be found to be dependent on those secondary structural changes that follow inflammatory action. I have never known a patient to recover completely and entirely, so as to be in the same state of health that he enjoyed before the accident, in whom the symptoms dependent on chronic inflammation of the cord and its membranes, and on their consecutive structural lesions, had existed for twelve months. And though, as Ollivier has observed, such a patient may live for fifteen or twenty years in a broken state of health, the probability is that he will die within three or four. There is no structure of the body in which an organic lesion is recovered from with so much difficulty and with so great a tendency to resulting impairment of function, as that of the spinal cord and brain. And, with the exception probably of the eye, there is no part of the body in which a slight permanent change of structure produces such serious disturbance of function as in the spinal cord.

Treatment of Concussion.—The general principles of treatment of the symptoms of concussion of the spinal cord are the same, from whatever cause the injury may have arisen.

In the *early stages* of a case of *concussion of the spine*, the first thing to be done is undoubtedly to give the injured part complete and absolute *rest*.

The importance of rest cannot be over-estimated. Without it, no other treatment is of the slightest avail; and it would be as rational to attempt to treat an injured brain or a sprained ankle without rest, as to benefit a patient suffering from a severe concussion or wrench of the spine unless he be kept at rest. In fact, owing to the extreme pain in movement that the patient often suffers, he instinctively seeks rest,

and is disinclined to exertion of any kind. It is the more important to insist upon absolute and entire rest in these cases, for this reason, that not unfrequently patients feel for a time benefited by movement; and hence such changes of air and scene are thought to be permanently beneficial. But nothing can be more erroneous than this idea, for the patient will invariably be found to fall back into a worse state than had previously existed. In more advanced stages of the disease, when chronic meningitis has set in, the patient suffers so severely from any, even the very slightest movement of the body, that he instinctively preserves that rest which is needed.

In order to secure rest efficiently, the patient should be made to lie on a prone couch. In the prone attitude, the spine is the highest part of the body; thus passive venous congestion and determination of blood, which are favored when the patient lies on his back, are entirely prevented. Again, the absence of pressure upon the back is a great comfort in those cases in which it is unduly sensitive and tender, and is a matter of additional safety to the patient, if he be paraplegic, by lessening the liability to the formation of bed-sores. Lastly, the prone position presents this advantage over the supine, that it allows the ready application to the spine of any local treatment that may be desired.

In some instances, complete and absolute rest may be secured to the injured spine by the application of a gutta-percha case to the back, embracing the shoulders, nape, and back of the head; or by letting the patient wear a stiff collar, so as to give support to the neck.

But, if rest is needed to the spine, it is equally so to the brain. In cases of concussion of the spine the membranes of the brain become liable to the extension of inflammatory action to them. The irritability of the senses of sight and hearing, that is so marked in many of these cases, with perhaps heat of head, or flushings of the face, are the best evidences of this morbid action. For the subdual of this state of increased cerebral excitement and irritability, it is absolutely necessary that the mind should be kept as much as possible at rest. The patient, feeling himself unequal to the fatigue of business, becomes conscious of the necessity of relinquishing it, though not perhaps without great reluctance, and until after many ineffectual efforts to attend to it.

During the early period of concussion of the spine, much advantage will usually be derived from dry cupping along the back on either side of the vertebral column. In some cases I have seen good effects follow the application of ice-bags to the injured part of the spine. At this period I believe that medicine is of little service beyond such as is required for the regulation of the general health on ordinary medical principles.

When the *secondary effects of concussion of the spinal cord* have begun to develop themselves, more scope presents itself for proper medical treatment, and much may often be done not only for the mitigation of suffering, but for the cure of the patient by carefully conducted local and constitutional treatment.

Rest, as in the early stages, must be persevered in; but, in addition to this, counter-irritation may now be advantageously employed. With this view the various forms in which this means is familiar to the surgeon—stimulating embrocations, mustard poultices, blisters, and setons or issues—may be successively used.

With regard to internal treatment, I know no remedy in the early period of the secondary stage, when subacute meningitis is beginning to develop itself, that exercises so marked or beneficial an influence as the bichloride of mercury in tincture of quinine or of bark. I have seen this remedy produce the most beneficial effects, and have known patients come back to the hospital to ask for the "bichloride" as the only medicine from which they had derived advantage. At a more advanced period, and in some constitutions in which mercury is not well borne, the iodide or the bromide of potassium in full doses will be found highly beneficial, more especially when there are indications of the presence and the pressure of inflammatory effusion.

When all signs of inflammatory action have subsided—when the symptoms have resolved themselves into those of paralysis, whether of sensation or of motion—but more especially in those cases in which there is a loss of motor power, with a generally debilitated and cachectic state, cod-liver oil, strychnine, and iron may be advantageously employed. But I would particularly caution against the use of these remedies, and more especially of strychnine, in all those cases in which inflamma-

tory action is still existing, or during that period of any case in which there are evidences of this condition. In such circumstances the administration of strychnine is attended by the most prejudicial effects, increasing materially and rapidly the patient's sufferings. But in the absence of this inflammatory irritation it will, if properly administered, be found to be a most useful remedy, more particularly in restoring lost motor power. In cases in which strychnine may be advantageously administered, great benefit will also be derived from warm salt-water douches to the spine, and galvanism to the limbs.

At a more advanced period of the case, when general cachexy has been induced, and more or less paralysis of sensation and motion continues in the limbs, and nothing of a specific nature can be done in the way of treatment, our whole object should be to improve the general health on ordinary medical principles, so as to prevent as far as possible the development of secondary diseases, such as phthisis dependent on malnutrition and a generally broken state of health, which may after a lapse of several years lead to a fatal termination.

WOUNDS OF THE SPINAL CORD.

These injuries may occur from stabs with pointed instruments; from gunshot violence; or, most frequently, from the pressure of fractured vertebræ. In the latter form of injury there is an association of wound and compression, giving rise essentially to the same symptoms as if the cord were divided.

Symptoms.—When the spinal cord is *completely divided*, a certain set of symptoms occur that are common to all cases, at whatever part of the cord the injury has been inflicted, provided it be not so high up as to cause instant death.

In the first place, there is *complete paralysis of sense and motion* in all the parts below the seat of injury, though the mental manifestations continue intact. The precise seat of injury may often be diagnosed by the extent of the paralysis. In injury of the lower part of the spine, there may be paralysis of all the parts supplied by the nerves of the sacral plexus, whilst those from the lumbar are not affected; the sensibility being lost below the knees, whilst above it is perfect—thus leading to the inference that the injury has been inflicted above the one and below the other set of nerves. The *temperature of the part becomes lowered;* though in some cases, when the paralysis is not quite complete, the reverse has been observed; and after a time, a visible *diminution takes place in its nutritive activity*, the circulation becoming feeble with a tendency to congestion at depending points. This lessening of nutritive vigor is not, however, confined to the paralyzed parts, but the whole of the system participates in it, the patient becoming speedily emaciated, anæmic and cachectic. The skin assumes a dirty cadaverous hue, and the cuticle usually exfoliates in branny flakes.

The lowering of the temperature, the disturbance in the processes of nutrition and secretion, and the partial supervention of emaciation and cachexy, are dependent upon a derangement in the vaso-motor influence exercised by the spinal cord. This kind of disturbance and its amount does not altogether arise from the simple division of the cord, but is rather the consequence of the inflammatory action set up in it and its membranes by the injury, and is greatly increased by all conditions that aggravate this irritation: thus it is that it is more marked in laceration of the cord and its continuous irritation by a fractured spine, than after its simple division with a cutting instrument.

These general symptoms of paralysis as the result of injury present important modifications, according to the point at which the cord is divided; the line of paralysis rising in proportion as the injury to the cord is higher.

1. When the injury has been inflicted in the *lumbar or lower dorsal region*, there will be found to be complete paralysis of all the parts supplied by the nerves given off from the sacral or lumbar plexuses, or both; hence there will be paralysis of the lower extremities, of the genital organs, and of the trunk as high as the seat of injury. There is always relaxation of the sphincter ani, with consequent incontinence of flatus, and, to a great extent, of feces. There is at first retention of urine in consequence of the paralyzed state of the bladder, which is unable to expel its contents; after a time, however, the urine dribbles away as fast as it is poured into the over-distended organ, the neck of which has lost its contractile sphincter-like action. The reason why there are incontinence of feces and retention of urine in

these cases is this: The sphincter ani and the muscular fibres of the bladder are both voluntary and under the influence of the spinal system. When paraplegia exists, the restraining power of the sphincter ani and the expelling power of the bladder are both lost. Hence the bladder cannot expel its contents; while the anus cannot retain those of the intestines, which are brought down to it by the peristaltic movements which are not spinal, but under the influence of the sympathetic nerve. After the first few days the urine will be observed to be ammoniacal in odor, and alkaline in reaction. This is probably owing to changes that it undergoes after it has passed into the bladder, the mucous membrane of which becomes chronically inflamed, secreting a viscid alkaline muco-pus, which mixes with the urine. In the early stages of the accident, the penis will usually be observed to be in a state of semi-erection. Patients who have met with injuries of this portion of the spinal cord may live on for many months, and even for a year or two, falling into a cachectic state, but eventually die, usually with slouging of the nates, or from the supervention of some intercurrent visceral inflammation of a low type.

2. When the cord is divided in the *upper dorsal region*, about the level of the third dorsal vertebra, we have not only the train of symptoms that have just been mentioned as characteristic of this injury lower down, but another set of symptoms is superadded to them, owing to the respiration being interfered with in consequence of the paralysis of the greater portion of the expiratory muscles. The intercostals, and those constituting the abdominal wall, no longer acting, imperfect expiration is solely effected by the elasticity of the walls of the chest; and those expiratory movements, such as sneezing and coughing, which are of a muscular character, cannot be accomplished. In these cases it will be noticed that during inspiration, which is effected almost exclusively by the diaphragm, the ribs are depressed instead of being expanded and raised; and that the abdominal wall, which is soft and flaccid, is protruded far beyond its normal limits. In consequence of the impediment to respiration the blood is not properly arterialized, and a slow process of asphyxia goes on, usually running into congestive pneumonia, and terminating fatally in about a fortnight or three weeks.

3. When the injury is situated in the *lower cervical region*, not only do all the preceding symptoms occur, but there is paralysis of the upper extremities as well; and, the inspiration being entirely diaphragmatic, the circulation speedily becomes affected, the countenance assuming a suffused and purplish look. If the cord have been divided immediately above the brachial plexus, there will be complete paralysis of the whole of the upper extremities; but if the injury be opposite the sixth cervical vertebra, it may happen that they are only partially paralyzed. This happened in two cases of fracture of the spine in this region that were some years ago under my care at the hospital. In both these instances the paralysis existed on the ulnar but not on the radial side of the arms, owing to the external cutaneous and radial nerves arising higher from the plexus than the ulnar, and thus just escaping injury. It is remarkable that, in both these cases, there was acute cutaneous sensibility in the arms along the whole line of junction between the paralyzed and the sound parts. In cases of injury of the cord in this situation, death usually occurs by asphyxia in the course of a week.

4. When the division of the spinal cord takes place *above the origin of the phrenic nerve*, opposite to or above the third cervical vertebra, instantaneous death results from the paralysis of the diaphragm, as well as of the rest of the respiratory muscles, inducing sudden asphyxia.

It necessarily happens in *partial division* of the cord, that the symptoms are not so clearly marked as in the instances that have just been recorded. Thus, for instance, the paralysis may not extend to all the parts below the seat of injury; it may be attended by severe pain in some of the semi-paralyzed parts; or motion may be affected in one limb, and sensibility in another. These deviations from what is usual may generally be explained by some peculiarity in the seat of the injury to the cord, or by the extent of its division.

MECHANICAL INJURIES OF THE VERTEBRAL COLUMN.

The mechanical injuries to which the vertebral column is liable, consist of sprains or wrenches, fracture, and dislocation.

Twists, Sprains, or Wrenches of the Spine, without fracture or dislocation of the vertebræ, may occur in a variety of ways.

Boyer relates a fatal case of this kind, occurring from an injury received in practising gymnastics. Sir A. Cooper gives an instance of a fatal wrench of the spine, from a rope catching a boy round the neck whilst swinging. In two cases, the injury also arose from violence applied to the cervical spine; in one from a railway accident, in the other from a fall from a horse.

These wrenches of the spine are, from obvious reasons, most liable to occur in the more mobile parts of the vertebral column, as the neck and loins; less frequently in the dorsal region.

In railway collisions, when a person is violently and suddenly jolted from one side of the carriage to the other, the head is frequently forcibly thrown forwards and backwards, moving as it were by its own weight, the patient having momentarily lost control over the muscular structures of the neck. In such cases the patient complains of a severe straining, aching pain in the articulations between the head and the spine, and in the *cervical spine* itself. This pain closely resembles that met with in any joint after a severe wrench of its ligamentous structures, but is peculiarly distressing in the spine, owing to the extent to which fibrous tissue and ligament enter into the composition of the column. It is greatly increased by to-and-fro movements, however slight, and especially by rotation; also by pressure, and by lifting up the head, so as to put the tissues on the stretch. In consequence of this, the patient keeps the neck and head immovable, rigid, looking straight forwards. He cannot raise his head off a pillow without the assistance of his hand, or that of another person.

The *lumbar spine* is often strained in railway collisions, with or without similar injury to the cervical portion of the column, in consequence of the body being forcibly swayed backwards and forwards during the oscillation of the carriage on the receipt of a powerful shock. In such cases the same kind of pain is complained of. There is the same rigidly inflexible condition of the spine, with tenderness on external pressure, and great aggravation of suffering on any movement being impressed upon it, more particularly if the patient bend backwards. The patient is unable to stoop; in attempting to do so, he always goes down on one of his knees.

These strains of the ligamentous structures of the spinal column are not unfrequently associated with some of the most serious affections of the spinal cord that are met with in surgical practice as a consequence of injury. They may of themselves prove most serious, or even fatal.

The *prognosis* will depend partly on the extent of the stretching of the muscular and ligamentous structures, partly on whether there is any inflammatory action excited in them which may extend to the interior of the spinal canal. As a general rule, where muscular, tendinous, and ligamentous structures have been violently stretched, as in an ordinary sprain, however severe, they recover themselves in the course of a few weeks, or at most within three or six months. If a joint, as the shoulder or ankle, continue to be weak and preternaturally mobile, in consequence of elongation of the ligaments, or weakness or atrophy of the muscles, beyond this period, it will, in all probability, never be so strong as it was before the accident. The same holds good with the spine; and a vertebral column which has been so weakened as to require artificial support, after a lapse of several months, in order to enable it to maintain the weight of the head, will not, in all probability, ever regain its normal strength and power of support.

One great prospective danger in strains of the spine is the possibility of the inflammation developed in the fibrous structures of the column extending to the meninges of the cord. This I have several times seen occur. It is particularly apt to happen when the strain or twist occurs between the occiput and the atlas or axis. In these cases a rigid tenderness is gradually developed, which is most distressing and persisting and evidently of an inflammatory character. Or the paralysis may remain incomplete, being confined to the nerves that are connected with that part of the spine that is the seat of the wrench, one or other of their roots either having suffered lesion, or the nervous cord itself having been injured in its passage through the intervertebral foramen. Lastly, a twist of the spine may slowly and insidiously be followed by symptoms of complete paraplegia, and eventually by death from extravasation of blood into the vertebral canal.

The *treatment* of these injuries is the same as that of concussion of the spinal cord (see page 368).

Fracture of the Spine may occur in two different ways; either by the application of direct violence to the vertebral column, or by a violent twist or bend of the body forwards. Direct violence, as by a blow or gunshot injury, may of course fracture the spine at any part and almost to any extent, in some cases merely detaching a spinous process, in others splintering and comminuting several vertebræ and lacerating or dividing the spinal cord. Fracture of the spine from a violent but forcible bend of the body forwards chiefly occurs in the cervical region. It is usually produced by a person falling from a height on the head, the body being bent forcibly forward so as to drive the chin against the sternum. This accident most usually happens in falls from horseback, or in a person taking a "header" into shallow water. In some cases it has occurred from a person sitting on the top of a carriage having the head forcibly bent down whilst passing under a gateway. In these accidents there are usually extensive rupture of the spinal ligaments and displacement of the bones, as well as fracture.

The extent of the fracture and the amount of displacement necessarily vary greatly. The spinous process merely may be broken off; or the arch may be broken through on each side of the spine; or the fracture may extend through the body of the vertebra.

In some cases of even very extensive fracture there may be no appreciable displacement; but usually some change of position has ensued, and in many cases to such an extent as to compress or lacerate the spinal cord. The mode of occurrence of the fracture will influence the amount of displacement. If the fracture be through the arch, or consist in a simple detachment of the spinous process by a fall or a blow on the back, there may be little or no displacement. If it occur from gunshot injury, or from a fall upon the head, or by forcible flexure of the neck and body forwards, as when the body is compressed between the top of a carriage and an archway, then there will probably be great displacement, and perhaps separation of the articulating surfaces of contiguous vertebræ.

The *signs* of this injury vary very greatly, and depend in a great degree upon the extent of the displacement. If this be inconsiderable, it may be extremely difficult, and even impossible in some instances, to pronounce with certainty whether the spine has been broken or not; the more so, if the fracture do not implicate the body of the vertebræ. If, on the other hand, the displacement be so considerable as to affect the axis of the column or to compress the cord, the symptoms are so marked as to admit of easy diagnosis. They are of two kinds; those presented by the injury of the bone, and those dependent on injury by compression or laceration, or both, of the spinal cord.

The *local signs* are usually pain at the seat of injury, greatly increased on pressure or on moving the part; inequality of the line of the spinous processes, with depression of the upper portion of the spine, and corresponding prominence of the lower. There is an inability to support the body in the erect position, and to move the spine in any way; hence, when the upper portion of the column is injured, the patient holds his head in a stiff and constrained attitude, fearing to turn it to either side.

The more *general symptoms* of fracture of the spine are dependent upon the injury which the cord has received. If the fracture have not implicated the spinal canal, as when only the tip of a spinous process has been broken off, or if it be unattended by displacement, although it may traverse the body and arches, no symptoms depending upon injury of the cord need exist, and indeed occasionally they are absent. But even in these cases, there is usually some degree of paralysis, owing perhaps to the concussion to which the cord has been subjected at the moment of injury; and occasionally a sudden movement by the patient will bring on displacement, by which the cord is compressed and all the parts below the injured spot are paralyzed. A woman was admitted into University College Hospital with an injury of the neck, the nature of which could not be accurately ascertained. She was in no way paralyzed, but kept her head immovable in one fixed position. A few days after admission, whilst making a movement in bed, by which she turned her head, she fell back dead. On examination, it was found that the spinous process of the fifth cervical vertebra had been broken off short, and was impacted in such a way between the arches of this and the fourth as to compress the cord. This

impaction and consequent compression probably occurred at the time of the incautious movement, thus producing immediate death.

When there is only partial displacement of the fracture there may be but incomplete paralysis of the parts below the injury; of one arm, one leg, &c. In these cases there is usually great pain experienced at the seat of fracture, and extending from it along the line of junction between the paralyzed and sound parts round the body or along the limb. This symptom, which is of great importance as exactly defining the seat of injury, is owing, as I found in dissecting a case of fracture of the sixth cervical vertebra under my care, to the fractured bone compressing and irritating the nerve that issues from the vertebral notch opposite the seat of injury.

In the majority of cases of fracture of the spine there is, however, such displacement of the bone as to compress the whole thickness of cord, and thus to occasion complete paralysis. In these cases the symptoms somewhat resemble those that arise from simple division of the cord, so far as their paralytic character goes, but exceed these in intensity in respect to the impairment of nutrition induced by them, as shown in wasting cachexy, a tendency to sloughing, and alkaline urine. The difference is, that in the case of fracture the cord is not simply compressed or divided, but is continuously irritated by the edges of broken bone, and thus not only becomes insusceptible of any healing process, but is kept in a state of chronic irritation and inflammation.

Prognosis.—Fractures of the spine through the bodies of the vertebra, with displacement, are inevitably fatal. Death occurs in three different ways in these injuries. It happens primarily and instantaneously, as the direct and immediate consequence of the injury, in all those cases in which the fracture is above the origin of the phrenic nerve. It occurs secondarily and indirectly, and at a more or less remote period, as the result of changes in the body dependent on continued loss of innervation, in all cases in which the injury sustained by the cord is below the point indicated as essential in its integrity to the maintenance of life. At the seat of injury, of compression, and of disorganization, inflammatory action is necessarily developed; thence it spreads along the membranes and in the cord itself to a variable distance, giving rise to effusion in the canal and softening of the medulla. It is doubtless by the gradual extension upwards of these secondary inflammatory disorganizations, that death is ultimately occasioned; the mischief, when low down, leading to impairment of the actions dependent upon the integrity of the cord, and when high up extending to the origins of the phrenics and so suspending respiration.

The *treatment* of these injuries is sufficiently simple. No attempt at reduction can of course be made. All our efforts must be directed to the prolongation of life. With this view, if the fracture be in such a situation, at any point below the upper dorsal vertebræ, for instance, as will hold out a prospect of life being prolonged for a few weeks or months, means must be taken to prevent the occurrence of sloughing of the nates, an accident that is common, and usually of fatal termination, in these cases. The patient should therefore be laid at once on a water-bed, cushion, or mattress; he must be kept scrupulously clean, and his urine should be drawn off twice in the day at regular hours. If, as usually happens after a time, the bowels become confined, relief must be afforded by castor-oil or turpentine enemata. A nourishing diet must be administered, and perfect rest in one position enjoined. In this way life may be maintained for a considerable length of time; and it is probable that ossific union of the fracture may sometimes take place, though the patient may not recover from the paralysis, and will die eventually from disease of the cord.

As the fatal result of fracture of the spine is almost inevitable, and as it is undoubtedly dependent upon the injury sustained by the cord from its compression or division by the broken vertebra, the idea has naturally suggested itself to surgeons that life might be prolonged, and health perhaps restored, if the same operation were extended to the spine which is successfully employed in parallel cases of injury of the head; viz., the elevation and removal, if necessary, of the depressed portion of bone. This operation was originally proposed by Heister, and performed by Louis and Cline. It may be done as follows. The patient lying on his face, a free incision, several inches in length, from three to five, according to the extent of the injury, is made along the line of the spinous processes, dissecting away the muscular masses on either side of the spine, so as to expose the osseous surfaces. The spinous processes, at the seat of injury, should then be successively seized with

a pair of strong forceps, and gently but firmly moved, in order to see whether there is fracture at their base or supporting arches. If a portion of bone be completely broken off it may, after all ligamentous connections have been severed, be raised by the forceps or an elevator. Should one arch only be broken through, the uninjured one may be divided by cutting pliers or a Hey's saw; or, should both be unbroken, the surgeon may, if he think it prudent to proceed further, divide both in this way, and so remove them and the spinous process, exposing the theca of the cord. After the operation, the wound is to be simply dressed and the patient kept in the prone position.

The results of this operation are not very encouraging. It has been performed by various surgeons in different countries, but chiefly in America, about thirty times; and, although some temporary advantage seems to have occurred in a few of the cases, permanent success has only been obtained in one instance by Dr. Gordon, of Whitworth Hospital, Dublin. But, though so far the result has been but little satisfactory, ought surgeons to discard the operation? I think not: for this reason, that, as a fractured spine with serious lesion of the cord is an injury that cannot be recovered from, and has an almost invariably fatal termination, and as the evil consequences of the fracture are dependent not only upon the primary lesion of the cord, but on the secondary disorganizing and inflammatory processes set up in it by the continued irritation of the fractured fragments, we are justified in attempting the removal of this source of certain misery and impending death by the only means in our power—operative procedure; and we are the more justified in this course, as the operation is not necessarily dangerous to life, does not appear often to have hastened the patient's death, and has certainly, in some cases, afforded relief of the most marked character, the paralytic symptoms disappearing to a great extent, and the patient being able to move limbs that were previously motionless.

One serious objection that has been urged against the operation must not, however, be overlooked. It is, that in the great majority of cases the fracture of a vertebra is through the body and not through the arches. This undoubtedly is so, and it is this circumstance that has rendered the operation as yet little more than a means of giving relief when the cord is partially divided and lacerated by being stretched over a rough and jagged edge of the broken body of a vertebra thrust back against it. Little more than temporary relief can be expected from the removal of the pressure from behind by cutting away the arches. But, when these portions of the spinal column only happen to be fractured and displaced, a rare condition it is true, then permanent good may be expected to follow the operation. If signs of such injury exist, as evidenced by distortion or depression of one or more spinous processes, then it would most certainly be quite proper for the surgeon to adopt the only means in his power of affording relief to the patient. The principal danger and usual cause of death after cutting away a portion of the spine is, undoubtedly, either the continuance of the inflammation excited by the injury in the cord and its membranes, or its increase or development by the operation itself.

Dislocations of the Spine.—On looking at the arrangement of the articular surfaces of the vertebræ, the very limited motion of which they are susceptible, and the way in which they are closely knit together by strong ligaments and short and powerful muscles, it is obvious that dislocations of these bones must be excessively rare. So seldom, indeed, do they occur, that their existence has been denied by many surgeons. Yet there are a sufficient number of instances on record to prove incontestably that these accidents may happen. Those cases that have been met with have usually been associated with partial fracture, but this complication is not necessary. In all, the displacement was incomplete; and, indeed, a complete dislocation cannot occur.

Dislocation of the atlas from the occipital bone has been described in two instances only—by Lassus and by Paletta. In the case by Lassus, death ensued in six hours, and the right vertebral artery was found to be ruptured. In the other case, the patient is said to have lived for five days, but the report is so incomplete, that little value can be attached to it.

Dislocation of the axis from the atlas is of more frequent occurrence. It may happen with or without fracture of the odontoid process. In either case the axis is carried backwards and the spinal cord thus compressed. This accident is said to have been caused by a person in play lifting a child off the ground by its head; the

combination of rotation and traction in this movement being especially dangerous, and liable to occasion the accident. For the same reasons, it has been met with in persons executed by hanging. Death would probably be instantaneous under these circumstances. It has, however, been stated that, in dislocations of this kind, life has been saved by the surgeon placing his knees against the patient's shoulders, and drawing or twisting the head into position. This, however, I cannot believe possible if the displacement have been complete, as death must be instantaneous, the cases of supposed dislocation and reduction having probably been instances of concussion of the cord with sprain of the neck.

Dislocation of any one of the five lower cervical vertebræ may occur. The third vertebra is that which is least frequently dislocated; the fifth that which is more commonly displaced. These injuries are usually associated with fracture; but sometimes, though rarely, they happen without this complication. In these dislocations, as in those that have already been described, the displaced bone carries with it the whole of that portion of the vertebral column which is above it, no single bone being dislocated either among those above or those below the displacement.

These accidents most commonly happen from forcible flexion of the neck forwards, though traction and rotation conjoined have occasioned them. In a case of luxation of the sixth and seventh cervical vertebræ, recorded by J. Roux, the accident happened to a sailor plunging into the sea for the purpose of bathing, and coming head foremost against a sail which had been spread out to prevent the attack of sharks; he died on the fourth day. In a patient of mine, who fell out of a window in such a way that the head was doubled forwards upon the chest, and who was brought to the hospital with supposed fracture of the spine, we found after death, which occurred on the fifth day, that the seventh cervical vertebra, carrying with it the upper portion of the spine and the head, had been dislocated forwards from the first dorsal, there being a wide gap posteriorly between the laminæ of these bones, with horizontal splitting of the intervertebral substance, detaching with it an extremely thin and small layer of bone from the body of the seventh. There was no fracture about the articular processes, which were completely separated from one another. The symptoms of this accident are necessarily excessively obscure, being very liable to be confounded with those of fracture. *Reduction* has been effected in a sufficient number of cases of this kind to justify the attempt being made when danger is imminent.

Dislocation of the transverse processes of the cervical vertebræ occasionally occurs. In these cases the patient, after a sudden movement, or a fall on the head, feels much pain and stiffness in the neck, the head being fixed immovably, and turned to the opposite side to that on which the displacement has occurred. In these cases I have known *reduction* effected by the surgeon placing his knees against the patient's shoulders, drawing on the head, and then turning it into position, the return being effected with a distinct snap.

In the *dorsal region*, dislocation of the spine, though excessively rare, may occur; seldom, however, without being accompanied by some amount of fracture. The last dorsal vertebra has been several times found dislocated from the first lumbar, with rupture of the intervertebral fibro-cartilage. In these cases, however, there has usually been found fracture of the transverse processes of the first lumbar vertebra, or, as in an instance recorded by Sir C. Bell, fracture of its body.

I am not acquainted with any case in which dislocation without fracture of the *lumbar* spine has been observed.

[A careful study of the literature of injuries of the spine has led me to form somewhat different conclusions from those of the author. Of 394 cases which I have tabulated and analyzed in an essay published in 1867, no less than 124 were reported by the surgeons who observed them as cases of *pure dislocation*. Though I am disposed to think this proportion too large, it proves, I think, that spinal dislocations are more frequent than is generally supposed. Most of these cases were of course in the cervical region, though dislocations of both the dorsal and the lumbar spine are represented in my tables.

Not only can the *position of the cord lesion* be ascertained during life, as said by the author, but its extent in a downward direction can be determined by the electrical test of M. Landry. This depends upon the fact that each segment of the cord acts as a separate nerve-centre. Thus, if the muscles of the thigh cease to respond to electricity, while those of the leg, though equally paralyzed, continue

to respond to the electric stimulus, it may be inferred that the lesion of the spinal cord is limited to the portion that supplies nerves to the femoral muscles, while that part which supplies the muscles of the leg remains healthy.

The author, in common with most writers, speaks of *incontinence of feces* as universally met with in serious spinal injuries. Brodie, on the other hand, taught that *costiveness* was always produced by the injury, and that the exceptions were such merely in appearance. The truth seems to be, as shown by Hilton, that when the lowest portion of the cord is injured, incontinence follows; whereas when the injury is higher up, this part continues to act as a separate nerve-centre, and costiveness necessarily results. *Priapism*, contrary to the teaching of Brodie, is met with in cases of injury below the sixth dorsal vertebra. *Elevation of the animal temperature*, which is but slightly referred to by the author, is a symptom of great importance, and if persistent, gives reason to expect a fatal termination: it is, I believe, only met with in injuries of the cervical and dorsal regions. The *prognosis* of spinal injuries is not so gloomy as represented by the author, and as generally believed. The *mortality* (as shown by my tables) varies from 77 per cent. in the cervical, to only 60 per cent. in the lumbar region, while the proportion of *recoveries* rises from 18 per cent. in the cervical, to 26 per cent. in the lumbar region. The proposal of *spinal resection* was not original with Heister, but had been recommended by many writers, from the days of Paulus Ægineta down to modern times. Louis' operation was not, strictly speaking, a resection, but consisted merely in the removal of some loose pieces of bone in a case of gunshot fracture. Spinal resection is not unattended with danger in itself—at least one case (Willett's) having terminated fatally before the completion of the operation. I have collected 33 cases in which spinal resection has been performed, and death is known to have followed in 25, a mortality of 76 per cent. for all regions. Dr. Gordon's patient, twelve months after the operation, could neither stand nor walk. Recovery with ability to resume an active life has frequently been obtained by the ordinary modes of treatment: *there is no well-authenticated instance of recovery after spinal resection.* I would respectfully invite the attention of the reader who may be interested in spinal injuries to the essay already referred to, for further remarks upon this subject.—A.]

CHAPTER XXIV.

INJURIES OF THE FACE AND ADJACENT PARTS.

Face.—Cuts about the *cheeks and forehead* are of common occurrence. These injuries present nothing peculiar, except that the structures of the face partake of the same tendency to ready repair, as well as to the supervention of erysipelatous inflammation, that characterizes the scalp when injured.

In the *treatment* of these wounds, it is of much consequence to leave as little scarring as possible. Hence the edges, after being well cleaned, should be brought neatly into apposition by fine hare-lip pins and twisted suture, or by a few points of interrupted suture; more particularly if the wound be in a transverse direction, and implicate the lips or nose. When the wound is in the neighborhood of the eyelids, especial care must be taken to prevent any loss of substance, lest the contraction of the cicatrix produce eversion of the lid. In those cases in which a portion of the nose or lip has been lost, much may be done to repair the deformity by properly conducted plastic operations, such as will be described in Chapter LVII. The bleeding, which is usually very free in wounds of the face, in consequence of some arterial branch having been divided, may often be arrested by passing the hare-lip pin under the vessel, and applying the twisted suture above it, so that it may be compressed.

If the *lip be cut from within*, by being struck against the teeth, the coronary artery may be divided, the patient swallowing the blood that flows into the mouth. Some years ago, a man was brought to the hospital, drunk, and much bruised about the face. Shortly after his admission he vomited a large quantity of blood, which

was at first supposed to proceed from some internal injury; but, on examining his mouth, it was found that the blood came from the coronary artery of the lip, which was divided, together with the mucous membrane.

Parotid Duct.—It occasionally happens as the result of wounds or abscesses of the cheek that the parotid duct is divided, in consequence of which the wound does not close, and a trickling of saliva takes place upon the outside of the cheek, so as to establish a *salivary fistula*, a source of much disfigurement and inconvenience to the patient; the surface surrounding it being puckered and somewhat excoriated, and the fistula opening by a granulating aperture.

If this condition be recent, a cure may sometimes be accomplished, by paring the edges of the external wound, bringing them into close apposition, and applying pressure upon the part. If it be of old standing, the probability is that the aperture into the mouth is closed, and that something more will be required than bringing the lips of the wound together. With this view, the operation that will be described in Chapter LV. must be had recourse to.

Besides the fistula of the Stenonian duct, other fistulous apertures may take place in the cheek, as the result of injury or disease, allowing the escape of a small quantity of saliva. These openings are always difficult to heal; the edges becoming callous, and not readily taking on reparative action. Closure may be effected in some cases by cauterization with the nitrate of silver, or with a red-hot wire, due attention being paid to the general health. In other cases, again, the electric cautery may prove successful. If, however, the opening be free, with much indurated structure about it, the surgeon may find it necessary to excise a portion of the edges before bringing them together.

Nose.—*Foreign bodies*, such as pebbles, beads, dried peas, &c., are occasionally met with in the nostrils of children, having been stuffed up in play, and becoming so firmly fixed as to require extraction by the surgeon. For this purpose a pair of urethral or polypus forceps will usually be found convenient. In some cases, however, a bent probe or an ear-scoop will remove the impacted body most easily.

[Foreign bodies may occasionally be conveniently removed from the nose by means of Thudichum's douche; the current being of course directed through the unaffected nostril.—A.]

The **Ears** are not unfrequently *wounded* in injuries of the head and scalp; a portion of the external ear being sometimes torn down and hanging over the side of the face. In these cases, as in scalp injuries, the part should never be removed, but, however lacerated and contused, should be cleaned and replaced by means of a few points of suture and strips of plaster. When the cartilaginous portion of the ear is divided, nice management is usually required in effecting perfect union.

Foreign bodies are often pushed into the ears of children in play with one another. When pointed or angular, such as pieces of stick, they may readily be extracted with forceps; but when round and small, such as pebbles or beads, they are not so easily removed. Hence the bent ear-scoop may occasionally be got round the body so as to remove it.

Fig. 169.

Ear-scoop.

[Mr. Hutchinson has recently recommended a wire loop as perfectly safe and more effectual than any other means of removing foreign bodies from the ear. (*Lond. Hosp. Reports*, vol. iv. p. 221.)—A.]

In some cases I have found an instrument, here represented (Fig. 169), and made by Coxeter on the model of Civiale's urethral scoop, useful in extracting a foreign body from the ear. It can be introduced straight and then passed beyond it, when, by the action of a screw in the handle, the scoop is curved forwards, and so enables extraction to be readily effected. In other cases the foreign body is best removed by forcibly syringing the ear with tepid water, injected by means of a large brass syringe in a full stream, the pinna being drawn up so as to straighten the external meatus. In this way the bead or pebble is soon washed out by the reflux of the water striking against the tympanum. Should these means not suffice, it is better to leave matters alone, and to allow the foreign body to become loosened, than to poke instruments into the ear with the view of forcibly extracting it. These attempts are ill-advised; and I have known death to follow prolonged and unsuccessful efforts at the extraction of a pebble from the ear.

Orbit.—Injuries of the orbit may be dangerous, either to the brain or to the eye.

If deep and directed upwards, they are always serious, on account of the proximity of the brain; thus it may happen that a pointed body, such as a piece of stick, the end of an umbrella, or a knife thrust into the orbit, fractures and perforates its superior wall, producing a fatal wound of the brain. The injury to the brain through the orbital plate of the frontal bone may be fatal by the consecutive cerebral inflammation that is induced; or the thrust may extend deeply, and, lacerating the internal carotid artery, occasion fatal hemorrhage. In one remarkable case recorded by Nélaton, a young man was wounded by the thrust of the point of an umbrella in the orbit; the cavernous sinus and internal carotid artery on the opposite side were wounded, an arterio-venous aneurism formed, the eyeball became prominent, and death by hemorrhage eventually resulted from the giving way of the diffused arterio-venous aneurism. Occasionally inflammation is set up in the loose cellulo-adipose tissue contained in this cavity, giving rise to abscess which may point in either eyelid; or, to inflammation extending itself to the encephalon. In other cases, wounds of the orbit may be followed by loss of vision, without the eyeball being touched; either in consequence of injury of the optic nerve, or perhaps from the division of some of the other nerves of the orbit producing sympathetic amaurosis, as occasionally happens even from ordinary wounds of the face, implicating some of the terminal branches of the fifth pair.

Eye.—Injuries of the eyeball are so commonly followed by impairment or total loss of vision as to constitute a most important series of accidents; the delicacy of the structure of this organ being such, that slight wound of its more transparent parts, or displacement of the lens, is often followed by complete opacity and loss of sight.

Injuries of this organ may be divided into contusions and wounds.

Contusion of the eyeball, without rupture or apparent injury of any of its structures, may give rise to such concussion of the retina as to be followed by temporary or permanent amaurosis. More frequently, contusions of the eye are accompanied by extravasation of blood under the conjunctiva, and much ecchymosis of the eyelids. A "black eye" is best treated by the continuous application of a weak spirit lotion.

Contusion of the eye with rupture of some of the structures of the ball is a most serious accident. The cornea may be ruptured, the humors lost, and vision permanently destroyed. Most frequently the rupture is internal, the outer tunics escaping all injury. In this case we may have an extravasation of blood into the eye, completely filling the anterior chamber, hiding and complicating deeper mischief within the ball. This condition, termed *hæmophthalmia*, is frequently associated with separation of the ciliary margin of the iris. In other cases, again, there may be displacement of the crystalline lens, which may be driven into the vitreous humor, be engaged in the pupillary aperture, or fall forwards into the anterior chamber. As a consequence of such injuries, the eye usually becomes inflamed, with intense frontal and circumorbital pain; disorganization of the ball, and ultimate loss of vision, ensuing.

The *treatment* of these injuries must always be of an active antiphlogistic character. Blood should be freely taken from the arm by venesection, and from the temple by cupping, the iris being dilated by the application to the eye of a solution of the sulphate of atropine, of the strength of two grains to an ounce of distilled water; the patient must be kept in a darkened room, on a strictly antiphlogistic regimen, and should be put under the influence of calomel and opium as speedily as possible. In this way the inflammation will be subdued, the effused blood absorbed, and perhaps vision restored. In some cases, however, opaque masses and bands of lymph will be deposited in the anterior chamber and the pupillary aperture, preventing more or less completely the entry of light. If the lens be displaced into the posterior chamber, it must be left there; if into the anterior, it may be extracted through the cornea.

Wounds of the eyeball may be divided into those that are merely superficial, and do not penetrate into its chambers; and those that perforate its coats.

Non-penetrating wounds are usually inflicted by splinters of iron, or other metallic bodies, which become fixed in the cornea, or between one of the eyelids and the ball. Very painful and troublesome injuries are sometimes inflicted by scratches of the eyeball with the nails of children.

In the *treatment* of these superficial injuries, the first point is necessarily to

remove any foreign body that is lodged. If it be fixed on the cornea, as commonly happens, it may be picked off with the point of a lancet or cataract-needle; if it be a splinter of iron that has been so lodged, it is well to bear in mind that a small brown stain will be left after the metallic spiculum has been taken off; this, however, will disappear in the course of a few days. In order to remove foreign bodies lodged between the ball and the eyelids, the latter must be everted so that the angle between the palpebral and the ocular conjunctiva may be properly examined. For this purpose the lower eyelid need only be drawn down, whilst the patient is directed to look up; but the eversion of the upper eyelid requires some skill. It is best effected by laying a probe horizontally across it, immediately above the tarsal cartilage; the surgeon then, taking the eyelashes and ciliary margin lightly between his finger and thumb, draws down the eyelid at the same time that he everts it by pressing the probe firmly backwards and downwards against the eyeball; the patient should then look down in order that the whole of the upper part of the conjunctiva, where the foreign body will probably be found, may be carefully examined.

[In some cases where the foreign body is situated very high up under the upper lid, or where it is impossible to evert the lid from spasm of the orbicular muscle, the offending object may be removed by sweeping out the fold of the eyelid with a small camel's hair brush previously moistened: in this way I have succeeded several times when other means have failed.—A.]

Penetrating wounds of the eyeball present great variety; they are commonly inflicted by bits of stick, steel-pens, children's toys, and not unfrequently during the shooting season by the explosion of faulty percussion caps, or the lodgement of a stray shot in the eye. In all cases these accidents are highly dangerous to vision; and, when the foreign body lodges, sight is usually permanently lost.

The danger that ensues usually arises either from the eye being opened to such an extent that the humors escape, or else that, the iris becoming engaged in a wound in the cornea, a hernial prolapse of it occurs. The remoter consequences usually arise from inflammation taking place within the globe, so as to produce an opaque cicatrix of the cornea or of the capsule of the lens; or else there is danger that adhesions may form, stretching across between the iris and the lens, or between these parts and the posterior surface of the cornea; or that inflammation may take place in all the structures of the ball, giving rise to rapid and deep disorganization of it.

The *treatment* of penetrating wounds is strictly antiphlogistic. Bleeding in the arm, cupping on the temples, low diet, a darkened room, and the administration of calomel and opium, are the principal points to be attended to. If the iris have protruded through a wound in the cornea, it should be carefully pushed back, and a drop or two of the solution of atropine put upon the eye. If it cannot be returned, it may be removed with a pair of fine curved scissors; and, at a later period, any staphylomatous tumor that may form should be touched repeatedly with a pointed piece of nitrate of silver. If there be a tendency to the formation of adhesions, or to the deposit of lymph within the pupil or the anterior chamber, our principal reliance should be upon small doses of calomel, in conjunction with opium. If the lens or its capsule have become opaque, traumatic cataract thus forming, extraction may be required at a later period of the case.

If the eye be so extensively opened up or deeply injured that vision is irreparably lost, and extensive suppurative inflammation in it and in the structures of the orbit is threatened, the sooner the globe is extirpated the better; the patient by this operation being saved much local and constitutional disturbance, and the danger of sympathetic affection of the other eye being diminished.

Mouth.—Wounds of the mouth are seldom met with, except as the result of gunshot violence. In these cases the amount of injury done to the soft structures, however great, is usually only secondary to the mischief that results to the brain, spinal cord, jaws, and skull, and must of course be treated on the ordinary principles of treatment of gunshot and lacerated wounds.

Tongue.—Wounds of the tongue usually occur from its tip or sides being caught between the teeth during an epileptic fit. They have been known to be inflicted by insane patients, in attempts to excise or to bite off this organ. Should the hemorrhage be free, the application of a ligature, or even of the actual cautery, may be needed to arrest it. These wounds generally assume a sloughy appearance for a few days; then clean up, and granulate healthily. It is useless to bring the edges together by sutures, which readily cut out. If, however, a large portion of the tip

be nearly detached, it must be supported in this way; but the threads should be thick and passed deeply. Pieces of tobacco-pipe are occasionally driven into and broken off in the substance of the tongue, and they thus either give rise to very free hemorrhage, or the wound may close and heal over the foreign body, the existence of which may not be known to the patient. In a case of this kind I found a man complaining of much pain and stiffness in the tongue, with difficulty in deglutition. On examination I found a hard swelling towards the base of the organ; and on cutting down upon this extracted three inches of the stem of a tobacco-pipe, which had been lodged there for several months.

The Palate and the Pharynx are sometimes lacerated by gunshot injuries of the mouth; or the wound may result from something that the patient happens to have between his lips being driven forcibly backwards into his mouth. Thus a tobacco-pipe may, by a blow on the face, be driven deeply into the substance of the tongue, or perhaps into the pharynx, wounding and lodging behind the arches of the palate, breaking off short; the fragment that is left in giving rise to abscess, to ulceration of the vessels, and perhaps to fatal secondary hemorrhage. In a case that was under my care some time ago, the soft palate was nearly completely detached from the palatal bones by a deep transverse wound, caused by the end of a spoon being forcibly driven into the mouth; good union took place eventually, the part having been stitched together by a few points of suture.

CHAPTER XXV.

INJURIES OF THE THROAT: AND ASPHYXIA.

INJURIES OF THE LARYNX AND TRACHEA.

Dislocation and Fracture of the Larynx.—The cartilages of the larynx may be displaced, dislocated as it were, by violent blows; or they may be fractured by a squeeze, the rupture in some cases taking place transversely, in others longitudinally. Digital examination of the part will at once detect the nature of the injury. In all these injuries there is danger of asphyxia, which indeed may be induced by simple concussion of the larynx. Should these symptoms be very urgent, tracheotomy may be required; if not, attention to position and support of the head will suffice.

[Dr. William Hunt, of this city, has collected a number of cases of fractured larynx, and his statistics show that whenever emphysema or hæmoptysis give reason to suspect laceration of the mucous membrane, laryngotomy, or tracheotomy should be at once performed. The mortality without operation was 79 per cent., and after operation only 25 per cent. (*American Journ. Med. Sciences*, April, 1866, pp. 378–383).—A.]

Wounds of the Throat.—These are of great frequency and equal importance, implicating as they do some of the most important organs in the body. They may be divided into three categories:—

1. Those that do not extend into the air or food-passages.
2. Those that implicate the air-passages, with or without injury of the œsophagus.
3. Those that are accompanied by injury of the spinal cord.

All these injuries are most commonly suicidal, and may be inflicted with every variety of cutting instrument; except where the spinal cord is injured, which must, in cases of suicide, be the result of gunshot wound, and is necessarily fatal. Though incised, they are often jagged, and partake somewhat of the character of lacerated wounds, with great gaping of the edges.

1. *Wounds not extending into the air or food-passages.*—In these wounds, there is very commonly free and even fatal hemorrhage, and this sometimes though none of the larger arterial or venous trunks have been divided; the blood flowing abundantly from the venous plexuses and from the thyroid body. If the larger arteries be touched, as the carotid and its primary branches, the hemorrhage may be so

abundant as to give rise to almost instantaneous death. Another source of danger in these cases proceeds from the admission of air into the veins of the so-called "dangerous region" of the neck. For this a free wound is by no means necessary, as is instanced by a remarkable case that occurred some years ago near London, in which the introduction of a seton into the fore part of the neck was followed by death from this cause.

Wounds of the internal jugular vein are necessarily very dangerous. There is not only the ordinary risk of primary hemorrhage from a vessel of such large size and directly communicating with the cerebral sinuses, but the special danger of the introduction of air into it; should these accidents be safely got over, the secondary ones of recurrent hemorrhage and pyæmia may yet have to be met. The ligature of the vessel above and below the wound in it, exactly as if it were an artery that had been opened, is the only course that can be safely pursued. In one case in which this was being done I saw and heard air enter the vein as it was being raised for the passage of the ligature, but the patient made a quick recovery.

The large nerves, such as the vagus and phrenic, can scarcely, in a suicidal wound, be divided without injury to the neighboring vessels. The division, however, of the respiratory nerves on one side only, or even of one of them, would in all probability be fatal in man, by interfering with the proper performance of the respiratory act. In a case with which I am acquainted, where the phrenic nerve was divided during the operation of placing a ligature on the subclavian artery, death resulted in a few days from inflammatory congestion of the lungs.

In the *treatment* of wounds of the neck of this category, the principal points to be attended to are, in the first place, the arrest of hemorrhage by the ligature of all bleeding vessels, whether arterial or venous; and, secondly, bringing together the lips of the wound. If the cut be longitudinal, this may be done by strips of plaster; if transverse, by a few points of suture and by position, the head being fixed, with the chin almost touching the sternum, and retained in this posture by tapes passing from the nightcap to a piece of bandage fixed round the chest. I have had under my care one case in which, owing to the projection and mobility of the larynx, the wound did not unite, a large and deep gap being left, which required a series of plastic operations in order to effect its closure.

2. *Wounds implicating the air-passages.*—The air-passages are commonly wounded in suicidal attempts. They may be known to be opened by the air being heard and seen to bubble in and out of the wound during respiration. These wounds vary much in extent, from a small puncture with the point of a penknife to a cut extending completely across the throat, and even notching the vertebræ. They are frequently complicated with injuries of the larger vessels and nerves, and sometimes with wound of the œsophagus. Most commonly the cut is made high up in the neck; for the suicide, thinking that it is the opening into the air-passages that destroys life, draws the razor across that part of the throat where these are most prominent and easily reached; and thus, by not wounding the larger vessels, which are saved by the projection of the larynx, frequently fails in accomplishing his object.

There are four situations in which these wounds occur: above the hyoid bone; in the thyro-hyoid space; through the larynx; and through the trachea.

They may be made *above the hyoid bone;* the cut extending into the mouth and wounding the root of the tongue. When the wound is in this situation it is usually attended with a good deal of hemorrhage; and there is much trouble in feeding the patient, as the power of swallowing is completely lost.

The wound may be inflicted in the *thyro-hyoid space*, laying the pharynx open, but being altogether above the larynx. This is the most common situation for suicidal attempts. In many cases the incision is carried so low as to shave off or partly to detach the epiglottis and the folds of mucous membrane around it. In other cases, the edges of the glottis or the arytenoid cartilages are injured, the cut extending back to the bodies of the vertebræ. Here also there is great difficulty in swallowing and great risk of the sudden supervention of œdema of the glottis, and consequent suffocation.

When the *larynx* is wounded the incision is usually transverse; but I have seen a longitudinal cut made through the larynx, so as to split the thyroid and cricoid cartilages perpendicularly. In these cases of wounded larynx, there is much danger of the blood from the superficial parts trickling into the air-passages and as-

phyxiating the patient, and of inflammation of the bronchi and lungs supervening at a later period.

Wounds of the *trachea* are not so common as those of the larynx, from which they differ but little in the attendant dangers.

The *œsophagus* is seldom wounded, as it can only be reached through the trachea by a deep cut, which will probably implicate the large vessels on one side or the other.

Effects.—There are various sources of danger in wounds of the neck implicating the air-passages. The *hemorrhage*, whether it proceed from any of the larger trunks, or consist of general oozing from a vascular surface, may either prove directly fatal by the loss of blood, or indirectly so in consequence of the blood trickling into the air-tube, and, by accumulating in its smaller divisions, producing suffocation.

Another source of danger in some of these cases arises from the supervention of *asphyxia*, either in the way that has already been mentioned, or, in those cases in which the wound has been inflicted above the larynx, from the occurrence of œdema of the glottis. This condition may likewise occur in those cases in which the external opening is very small, and occasionally happens suddenly when the wound is nearly closed.

Another source of danger is the *loss of the natural sensibility of the glottis*, in consequence of which it no longer contracts on the application of a stimulus. Hence food taken in by the mouth may pass into the larynx and make its appearance in the external wound, even though neither the pharynx nor the œsophagus has been wounded. This I have observed in many cases of cut-throat; hence the presence of food in the wound cannot in all cases be considered an evidence of injury to the food-passages. This occurrence is always a bad sign, and is never met with in the earlier periods of the injury; never, indeed, until a semi-asphyxial condition has come on, by which the nervous sensibilities are blunted, or until inflammation has been set up about the rima glottidis, giving rise to so much swelling as to interfere with the natural actions, and to deaden the perception of the part to the contact of a foreign body. In these cases also it will be found that the sensibility of the air-passages generally is much lowered, so that mucus accumulates in the bronchi, even to a dangerous extent, the patient not feeling the necessity for expectoration, and often, indeed, having much difficulty in emptying his chest.

The occurrence of *bronchitis* and *pneumonia*, either from the inflammation extending downwards from the wound, or in consequence of the cold air entering the lungs directly, without being warmed by passing through the nasal cavities, is perhaps the most serious complication that can happen in these injuries, and constitutes a frequent source of death in those patients who survive the immediate effects of the wound.

The *depressed mental condition* of the patient also is usually unfavorable to recovery in all those instances in which the wound is suicidal, disposing him to the occurrence of low forms of inflammatory mischief.

Treatment.—We have already considered the management of those wounds of the throat that do not interest the mucous canals in this region. When these are opened, the same general principles are required as in the former case. Hemorrhage must be arrested by the ligature of all the bleeding vessels, whether arteries or veins, so that no oozing or trickling into the wound may take place.

In some cases the hemorrhage consists principally of general venous oozing which cannot be stopped by ligature, the patient drawing a large quantity of blood into the air-passages through the wound in them. In these circumstances I have found it useful to introduce a large silver tube into the aperture in the windpipe, and to plug the wound around it. So soon as the bleeding has fairly ceased, the plugs and the tube must be removed.

The edges must next be brought together by a few stitches introduced at the sides, and by attention to position, the head being fixed by tapes as already described in the former section. I think, with Liston, that in these cases the wound should never be closely sewed up, nor stitches introduced into the centre of the cut. If the centre of the integuments be closely drawn together, coagula may accumulate behind them, in the deeper parts of the wound, so as to occasion a risk of suffocation; and, as this must eventually close by granulation, no material advantage can possibly be gained by this practice.

There is an exception, however, to this rule of not using stitches in the central part of the wound in cut-throat; viz., in those cases in which the trachea has been completely cut across. Here a stitch or two on each side of the tube is necessary, in order to prevent the wide separation of the two portions that would otherwise take place, owing to the great mobility of the larynx and upper end of the windpipe.

[The sutures (which in this case should be of fine thread) may be even passed superficially through the laryngeal or tracheal cartilages themselves, one end being allowed to hang out of the wound like a ligature to facilitate its removal.—A.]

In order to lessen the liability to inflammation of the lungs, the patient should be put into a room, the temperature of which is raised to about 80° Fahr., with a piece of lightly-folded muslin acting as a respirator laid over the wound. So soon as the cut surfaces begin to granulate, water-dressing may be applied, and the edges of the wound brought into apposition by strips of plaster, and a compress if necessary. During the treatment, the principal danger proceeds from inflammatory affections of the chest; these must accordingly be counteracted by the temperature in which the patient is placed, and by as active antiphlogistic remedies as his condition will admit of. It must, however, be remembered that the mental depression, and the bodily exhaustion from loss of blood, that are commonly met with in these cases, do not allow a very active course of treatment to be pursued.

The *administration of food* in these cases is always a matter requiring much attention. As a general rule, the patient should be kept on a nourishing diet, with a moderate allowance of stimulants. If, as not uncommonly happens, the food-passages are opened in consequence of the wound extending into the mouth, the pharynx, or the œsophagus, it is of course impossible for the patient to swallow, and the administration of nourishment becomes a source of considerable difficulty. This is best accomplished by means of an elastic gum catheter passed through the mouth into the gullet or stomach. This is easier than passing the instrument through the nose, and much better than introducing it through the wound. In this way a pint or more of the strongest beef-tea or soup, or Liebig's "extract of meat," mixed with two or three eggs, and having an ounce or two of brandy added to it, should be injected regularly night and morning, until the patient is able to swallow. In those cases in which the wound is above the larynx, there is occasional danger of the supervention of œdema of the glottis; should this occur, tracheotomy may become necessary in order to prolong the patient's life.

As consequences of wounds of the throat, we occasionally find stricture of the trachea, or aërial fistula. If the chordæ vocales happen to have been injured, loss of voice may result.

Aërial Fistula may sometimes form owing to the skin doubling in and becoming adherent to the edges of the wound in the air-tube, and most frequently occurs when the cut is in the thyro-hyoid space; adhesion taking place between the integuments, which are doubled in, and the os hyoides above and the surface of the thyroid cartilage below. The same will happen in the crico-thyroid space, and may indeed occur at any part of the larynx that has been opened. When this happens, there is a tendency to the fistula continuing patent. In these circumstances, I have found the following operation successful in closing it.

The edges of the fistulous opening having been freely pared, and the knife passed under them for some distance so as to detach them from the subjacent parts, a vertical incision is made through the lower lip of the opening—so as to split it downwards. Two points of suture are then inserted into each side of the horizontal incisions, bringing their edges into contact, *but the vertical cut is left free* for discharges and mucus to drain through, and for the expired air to escape, lest emphysema occur. Unless this outlet be afforded, these fluids will burst through the sutures, and thus destroy union of the edges.

It is not in every case that an aërial fistula can be safely closed. In some instances the larynx becomes contracted either by drawing in of the wound, or by thickening of the mucous membrane above the artificial opening to such an extent that the fistula becomes essential, in addition to the orifice of the glottis, for the purposes of respiration. In such circumstances, any attempt at closing it will be attended or followed by symptoms of impending asphyxia or collapse of the lungs; and it may be necessary to leave the opening free, or even, as happened in a case under my care, in which an opening was left in the crico-thyroid membrane of a

girl who had attempted suicide by cutting her throat, to enlarge the opening and to introduce a silver tube in order to relieve the breathing from the effects of the laryngeal constriction.

Foreign Bodies in the Air-passages.—Though the introduction of foreign bodies into the air-passages is not a very common accident, yet a great variety of substances that admit of being swallowed have been found there: such as nut-shells, beans, cherry-stones, teeth, meat, money, buttons, pins, fish-bones, bullets, pills, pebbles, and pieces of stick. These foreign bodies are not introduced into the air-passages by any effort of deglutition, for no substance can be *swallowed* through the glottis; but they are *inhaled;* thus, if a person, whilst holding anything in his mouth, make a sudden inspiration, the current of air may draw it between the dilated lips of the glottis into the larynx.

The *symptoms* vary, according to the situation in which the foreign body is lodged, its nature, and the period that has elapsed since the occurrence of the accident. The foreign body may lodge in one of the ventricles of the larynx; or, if light, it may float in the trachea, carried up and down by the movement of the air in expiration and inspiration. If too heavy for this, it will fall into one or other of the primary divisions of the trachea, and, as Aston Key has observed, will most commonly be found in the right bronchus, this being larger, and in a more direct line with the trachea than the left. If the substance be small, it may pass into one of the secondary divisions of the bronchi; and, if it continue to be lodged here for a sufficient length of time, may make a kind of cavity for itself in the substance of the lung, where it may either lie in an abscess, or become encysted.

The symptoms may be divided into three stages: 1. Those of obstruction, immediately following the introduction of the substance; 2. Those of irritation, produced by its presence; and 3. Those of inflammation, coming on at a later period.

1. *Symptoms of Obstruction.*—The immediate symptoms vary somewhat, according to the size and nature of the body, and the part of the air-tube that it reaches. In all cases there is a feeling of intense suffocation, with great difficulty of breathing, and violent fits of spasmodic coughing, often attended by vomiting; during which the foreign body may be expelled. Indeed, its partial entry and immediate extrusion by coughing are not uncommon. In some cases, immediate death may ensue at this period. If the body have entered the air-passages fully, there is violent coughing, with feeling of suffocation for an hour or two, accompanied by lividity of the face, great anxiety, and sense of impending death. There is also usually pain felt about the episternal notch. The symptoms then gradually subside, but any movement on the part of the patient brings them on again with renewed violence. All these symptoms are most severe if the foreign body remain in the larynx; the voice being then croupy, irregular in tone, or lost. If it be lodged elsewhere, so often as it is coughed up, and strikes against the interior of the larynx, an intense feeling of suffocation is produced; and if it happen to become impacted there, sudden death may result, even though it be not of sufficient size to block up the air-passage, apparently by the spasm that is induced. Some years ago a boy died at the Westminster Hospital before tracheotomy could be performed, in consequence of a flat piece of walnut-shell that had entered the trachea being suddenly coughed up, and becoming impacted in one of the ventricles of the larynx. The symptoms, during this period, are much less severe when the foreign body is in the trachea or bronchi.

2. *Symptoms of Irritation.*—When the foreign body has passed into the air-passages, and the immediate effects produced by its introduction have passed over, another set of symptoms, dependent on the irritation produced by it, is met with; and it is during the occurrence of these that the patient is most generally brought under the surgeon's observations. These symptoms are of two kinds: *general* and *auscultatory.*

The *general symptoms* consist of occasional fits of spasmodic cough, accompanied by much difficulty of breathing, a feeling of suffocation, and an appearance of urgent distress in the countenance. These attacks do not occur when the patient is tranquil, but come on whenever the foreign body is coughed up so as to strike the larynx, and the upper and more sensitive parts of the air-passages. As a general rule, the distress is less, the lower the substance is lodged; the sensibility of the inferior portion of the trachea and bronchi being much less acute than that of the larynx and the upper part of the trachea. In consequence of the irritation, there is usually

abundant expectoration of frothy mucus. These symptoms often remit for a time, more particularly if the foreign body become fixed. In some cases, indeed, there appears to be so little distress some days after the accident, that considerable doubt may exist in the mind of the surgeon, whether any foreign body really be lodged in the air-passages or lungs; and much valuable time is often lost by his indisposition to adopt active measures when the symptoms are not urgent.

The *auscultatory signs* depend necessarily upon the situation of the foreign body. If this be loose and floating, it may be heard, on applying the ear to the chest, moving up and down, and occasionally striking against the side of the trachea. If it be fixed, it will necessarily give rise to a certain degree of obstruction to the admission of the air beyond it, perhaps occasioning *bruits* during its passage. If it be impacted in the larynx, the voice will be hoarse and croupy, and there will be a loud rough sound in respiration, with much spasmodic cough and distress in breathing. If it be impacted in one bronchus, the respiratory murmur will be much diminished, or even absent, in the corresponding lung, and probably puerile in the other; whilst percussion will yield an equally clear and sonorous sound on both sides of the chest, air being contained in the lung of the obstructed side, but not readily passing in and out. If one of the subdivisions of either bronchus be occupied by the foreign body, the entrance of air will be prevented in the corresponding lobe of that lung, though it enter freely every other part of the chest. If the foreign body be angular, or perforated, peculiar sibilant and whistling noises may be heard as the air passes over and through it.

3. *Inflammation.*—After a foreign body has been lodged for a day or two, symptoms of *inflammation of the bronchi or lungs* are apt to be set up; in some cases, however, these only occur after a considerable time has elapsed, or, perhaps, not at all, much depending, of course, on the shape and character of the irritant. If it continue to lodge, it generally forms for itself a cavity in the substance of the lung, whence purulent and bloody matters are continually expectorated, until the patient dies in the course of a few months, or a year or two, of phthisis. It has occasionally happened, however, that the substance has been coughed up after a very long lodgment, the patient recovering. Thus, Tulpius relates a case in which a nutshell was coughed up after being lodged for seven years; and Heckster one in which a ducat was thus brought up after a lapse of two years and a half; the patients, in both instances, recovering. In other cases death may ensue, although the foreign body is coughed up; thus Sue relates an instance in which a pigeon-bone was spat up seventeen years after its introduction, the patient, however, dying in little more than a year from marasmus.

Prognosis.—This depends more upon the nature of the foreign body and its size than on any other circumstances. If it be rough, angular, and hard, there is necessarily much more risk than if it be soluble in, or capable of disintegration by, the mucus of the air-passages. So long as the foreign body is allowed to remain, the patient is in imminent danger, either from immediate and sudden suffocation, or from inflammation at a more remote period.

The danger depends greatly upon the length of time during which the body is allowed to lodge. Of 62 cases (4 of which have fallen under my own observation, the remaining 58 being collected from various sources, and constituting all those that I have been able to find recorded) I find the time that the foreign body was allowed to remain in, and the result of the case, stated in 49 instances, which I here tabulate:—

Period of retention.	Number of cases.	Recovered.	Died.
Less than 24 hours	8	6	2
Between 24 and 48 hours	4	3	1
Between 48 hours and 1 week	13	6	7
Between 1 week and 1 month	8	4	4
Between 1 month and 3 months	3	3	0
Between 3 months and 1 year	6	4	2
More than 1 year.	7	4	3
Total	49	30	19

From this it would appear that, if the patient escaped the danger of the immediate introduction, the greatest risk occurred between the second day and the end of the

first month, no fewer than 11 patients out of 21 dying during this period; and then that the mortality diminished until the third month, from which time it increased again.

The cause of death also varies according to the period at which the fatal result takes place. During the first twenty-four, and, indeed, forty-eight hours, it happens from convulsions and sudden asphyxia. During the first few weeks it is apt to occur from inflammatory mischief within the chest; and after some months have elapsed the patient will be carried off by marasmus or phthisis.

Spontaneous expulsion of the foreign body, usually in a violent fit of coughing, occasionally occurs. Gross, of Philadelphia, finds that there are 49 cases on record, in which the body was spontaneously expelled, the patient recovering. Of these, in 37 it was expelled during a fit of coughing. The period during which a foreign substance may remain in the air-passages before it is spontaneously expelled, varies from a few minutes to many months or years; in one case, a piece of bone introduced at the age of three, was not ejected until sixty years had elapsed. In 8 cases death followed the spontaneous expulsion.

Treatment.—This accident is always a very serious one, and hence requires prompt and energetic means to be used in order to save the patient; and fortunately the means at our disposal, consisting of the simple operation of opening the trachea, and thus facilitating the expulsion of the foreign body, are usually highly successful. I find that of 60 cases in which the result was noted, 37 lived, and 23 died; but on analyzing these cases more closely, it appeared that in 39 no operation was performed; the expulsion of the foreign body being trusted to the efforts of nature. Of these 23 died, and 16 lived. In the remaining 21 cases, tabulated below, tracheotomy was performed; of these 18 lived, and only 3 died, showing a remarkable success attendant on this operation.

Period of retention.	Number of cases.	Cured.	Died.
Less than 24 hours	3	2	1
Between 24 and 48 hours	2	2	0
Between 48 hours and 1 week	9	8	1
Between 1 week and 1 month	5	4	1
Between 1 and 3 months	2	2	0
Total	21	18	3

Gross has also given extensive statistics of the removal of foreign bodies, and has found that out of 68 recorded cases in which *tracheotomy* has been performed, the operation was successful in 60, and in 8 the patient died. In some cases *laryngotomy* has been performed instead of tracheotomy; and the foreign body has been equally well expelled. Gross gives 13 instances of this, successful in their results, to 4 in which death followed the operation. *Laryngo-tracheotomy* was done in 13 cases; of these there were 10 successes and 3 deaths.

Gross' statistics of 160 cases are as follows:—

	Recovered.	Died.	Total.
Spontaneous expulsion	49	8	57
Inversion of body alone	5	0	5
Tracheotomy	60	8	68
Laryngotomy	13	4	17
Laryngo-tracheotomy	10	3	13

Emetics, sternutatories, and succussion of the body, are all either useless or dangerous. Inversion of the body has succeeded in several instances, and might, I think, be tried before operation is had recourse to, more particularly if the foreign body be a coin, and is movable in the air-passages. Mr. Padley caused the ejection of a sixpenny piece in this way from the trachea of a man, and he recommends the supine as a safer and better position than the prone. There is undoubtedly danger, in inversion, of the supervention of laryngeal spasm, but statistics do not prove that any fatal consequences have resulted from this cause. Should, however, the attempt at expulsion by inversion of the body bring on an

attack of laryngeal spasm, the attempt should be abandoned as not only useless but in the highest degree dangerous, until the windpipe has been opened.

Operation.—If, therefore, a patient be seen a few hours, days, or weeks, after a foreign body has been introduced into the air-passages, or indeed at any period after the accident, and inversion have failed, tracheotomy ought to be performed. And this should be done, even though the symptoms be not urgent. There is often a remission in the symptoms, a lull, a period of deceptive security, by which the surgeon must not be put off his guard, but proceed without delay to tracheotomy. But, it may be asked, for what purpose is the trachea opened? Why should not the foreign body be expelled through the same aperture by which it has entered? The opening in the trachea performs a double purpose; it not only serves as a ready and passive outlet for the expulsion of the foreign body, but also as a second breathing aperture in the event of its escaping the glottis. The advantage of the opening in the trachea as a ready aperture of expulsion is evident, from the fact that, of 14 of the operated cases in which it is stated how the foreign body was expelled, I find that in 12 it was ejected through the artificial opening, whilst in 2 only did it pass out through the glottis.

The reason why the foreign body usually passes out of the artificial opening in preference to escaping by the glottis, is, that the sides of the former aperture are passive, whereas those of the latter are highly sensitive and contractile. Before the operation is performed, it will be found that the great obstacle to expulsion is not only the sensitiveness of the larynx, great irritation being induced when it is touched from within, but also the contraction of the glottis, by the closure of which not only is the expulsion of the foreign body prevented, but respiration is impeded. Every time the foreign body is coughed up so as to touch the interior of the larynx, intense dyspnœa is produced, owing to sudden and involuntary closure of the glottis, by which respiration is entirely prevented and suffocation threatened; the expulsion of the body is consequently arrested, unless it were by chance to take the glottis by surprise, and pass through it at once in the same way that it has entered it, without touching its sides. If there be a second breathing aperture, though the larynx is equally irritated by the foreign body, yet this dyspnœa cannot occur, respiration being carried on uninterruptedly by one opening whilst the foreign body escapes through the other; and thus, under these circumstances, it may pass through the glottis with but little inconvenience to the patient.

In some cases, the foreign body is expelled at once after the trachea has been opened; in others, not until some hours, days, or even weeks, have elapsed. Thus, in Houston's case, a piece of stick was not coughed up until ninety-seven days after the operation; and in Brodie's case, sixteen days elapsed before the half sovereign came away.

The expulsion has in some instances been facilitated by inverting the patient, shaking him, or striking him on the back. In cases in which the foreign body is not readily expelled, it has been proposed to introduce forceps and extract it. But, although in some instances this has succeeded, the uncertainty and danger of such a proceeding are so great that few surgeons will be disposed to attempt it; the introduction of the forceps producing violent irritating cough, during which their points might readily be driven through the bronchi, and thus wound the lung or contiguous important structures. Besides this, there would be the danger of seizing the projecting angle at the bifurcation of the bronchi instead of the foreign body, and thus injuring the parts seriously. If the foreign body be fixed, the safer plan will certainly be to leave the aperture in the trachea unclosed, and wait for the loosening of the body and its ultimate expulsion, which have hitherto occurred in all cases that have been operated on; or its escape might be facilitated by the gentle introduction of a probe, so as to dislodge it if seated in either bronchus, though this should be done with great caution; or the patient may be inverted and succussed, when the expulsion may take place. Should it not then escape, the wound should be kept open by means of blunt hooks, when, perhaps, it may be ejected.

Antiphlogistic treatment must be continued during the whole progress of the case. After the escape of the foreign body, the opening in the trachea must be closed.

Scalds of the Mouth, the Pharynx, and the Glottis, occasionally occur from attempts to swallow boiling water; or these parts are scorched by the inhalation of flame. The scalding of these parts chiefly happens to the children of the

poor, who, being in the habit of drinking cold water from the spout of a kettle, inadvertently attempt to take a draught from the same source when the water is boiling. The hot liquid is not swallowed, but, though immediately ejected, has scalded the inside of the mouth and pharynx, giving rise to a considerable degree of inflammation, which extending to the glottis, may produce œdema of it, and thus speedily destroy life by suffocation. In three cases which I have had an opportunity of examining after death, there was no sign of inflammation below the glottis, though the lips of this aperture were greatly swollen; and this I believe to be invariably the case, the inflammation not extending into the interior of the larynx, as was pointed out by Marshall Hall.

The accident always reveals itself by very evident signs; the interior of the mouth looks white and scalded, the child complains of great pain, and difficulty of breathing soon sets in; which, unless efficiently relieved, may terminate in speedy suffocation.

In those cases in which these parts have been similarly injured by the flame produced by the explosion of gas or of fire-damp being sucked into the mouth, the same conditions present themselves.

In the *treatment* of this injury, the main point to attend to is to subdue the inflammation before it involves the glottis to a dangerous extent. With this view, leeches should be freely applied to the neck, and calomel with antimony administered. If symptoms of urgent dyspnœa have set in, tracheotomy must be performed without delay; and, if the child be not too young, a tube must be introduced into the aperture so made, and kept there until the swelling about the glottis has been subdued by a continuance of the antiphlogistic treatment. In the majority of the cases, however, that have fallen under my observation, in which this operation has been performed, the issue has been a fatal one, from the speedy supervention of bronchopneumonia; but as it affords the only chance of life when the dyspnœa is urgent, it must be done, though its performance in very young children is often attended by much difficulty, from the shortness of the neck and the small size of the trachea.

ASPHYXIA.

The Surgical Treatment of Asphyxia includes the management of those cases in which respiration has been suspended by drowning, suffocation, hanging, or the inhalation of irrespirable gases. The general subject of suspended animation from these various causes cannot be discussed here, but we must briefly consider some points of practical importance in its treatment.

In cases of *drowning*, life is often recoverable, although the sufferer have been immersed in the water for a considerable time; for it must be borne in mind that, though *immersed*, he may very probably not have been *submersed*. The period after which life ceases to be recoverable in cases of submersion, cannot be very accurately estimated. The officers of the Humane Society, who have great experience in these matters, state that most generally persons are not recoverable who have been more than four or five minutes under water. In these cases, however, although submersion may not continue for a longer period than this, the process of asphyxia does; this condition not ceasing on the withdrawal of the body from the water, but continuing until the blood in the pulmonary vessels is aërated, either by the spontaneous or artificial inflation of the lungs. As several minutes are most commonly consumed in withdrawing the body from the water and conveying it to land, during which time no means can be taken to introduce air into the lungs, we must regard the asphyxia as continuing during the whole of this period; occupying, indeed, the time that intervenes between the last inspiration before complete submersion, and the first inspiration, whether artificial or spontaneous, after the removal of the body from the water. The latest time at which life can be recalled, during this period, is the measure of the duration of life in asphyxia. If, during this period, the action of the heart should cease entirely, I believe, with Sir B. Brodie, that the circulation can never be restored. But although we may put out of consideration those marvellous cases of restoration of life that are recorded by the older writers, and which are evidently unworthy of belief, are we to reject as exaggerated and apocryphal cases such as that by Smethurst, in which recovery took place after ten minutes' submersion; that by Douglas of Havre, in which the patient was not only submersed, but had actually sunk into, and was fixed in the mud at the bottom of the harbor

for from twelve to fourteen minutes; or that by Weeks, in which the submersion, on the testimony of the most credible witnesses, exceeded half an hour? I think that it would be unphilosophical in the extreme to deny the facts clearly stated by these gentlemen; the more so that in these, as in many other instances of apparent death from drowning, life appears to have been prolonged by the patient falling into a state of syncope at the moment of immersion. We must therefore not despair of recovery, but should employ means of resuscitation, even though the body have been actually under water a considerable time.

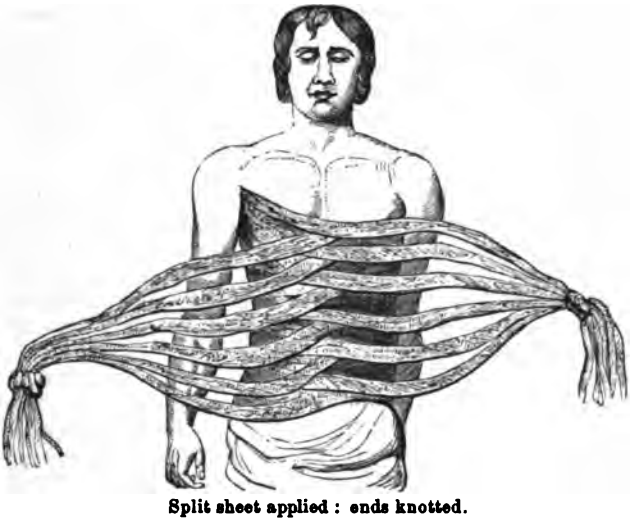
There are certain minor means often employed in the case of persons who have been immersed in water, and are apparently drowned, which appear to be well adapted for the treatment of the less severe forms of asphyxia, or rather cases of syncope from fright and immersion in cold water. These consist, after the nose and mouth have been cleared of any mucosities, in the application of heat by means of a bath at about the temperature of 100° Fahr. until the natural warmth is restored; in the employment of brisk friction; and in passing ammonia to and fro under the nostrils. It is evident that these measures can have no direct influence upon the heart and lungs, but can only act as general stimuli to the system, equalizing the circulation if it be still going on; and, by determining to the surface, tending to remove those congestions that are not so much the consequences of the asphyxia, as of the sojourn of the body for several minutes in cold water; they would therefore be of especial service during the colder seasons of the year. A hot bath may also, by the shock it gives, excite the reflex respiratory movements. With the view of doing this with a greater degree of certainty, cold water should be sprinkled or dashed upon the face at the time when the body is immersed in the hot bath, as in this way a most powerful exciting influence can be communicated to the respiratory muscles; and the first object of treatment in all cases of asphyxia—the re-establishment of respiration—would more rapidly and effectually be accomplished; deep gaspings ensuing, by which the air would be sucked into the remotest ramifications of the air-cells, arterializing the blood that had accumulated in the pulmonary vessels, enabling it to find its way to the left cavities of the heart, and thus to excite that organ to increased activity. These means, then, are useful in those cases of asphyxia in which the sufferer has been but a short time submersed, and in which the heart is still acting, and the respiratory movements have either begun of their own accord on the patient being removed from the water, or in which they are capable of being excited by the shock of a hot bath, aided by the dashing of cold water in the face. At the same time, the lungs may be filled with pure air, by compressing the chest and abdomen, so as to expel the vitiated air, and then allowing them to recover their usual dimensions by the natural resiliency of their parietes. A small quantity of air will, in this way, be sucked in each time the chest is allowed to expand, and thus the re-establishment of the natural process of respiration may be much hastened. This simple mode of restoring the vital actions should never be omitted, as it is not attended with the least danger, and does not in any way interfere with the other measures employed. Marshall Hall has recommended that the patient be turned prone, so that the tongue may hang forwards, and the larynx thus be opened; and that respiration be then set up by gentle pressure along the back, and by turning the patient on his side at regular intervals. If, by these, means, we succeed in restoring the proper action of the respiratory movements, it will merely be necessary to pay attention to some points of the after-treatment that will presently be adverted to. Should we, however, fail in restoring respiration, we should have recourse to other and more active measures.

In the more severe cases of asphyxia, warmth should be applied by means of a hot-air bath, by which not only the natural temperature of the body may be re-established, but the blood in the capillaries of the surface be decarbonized. The most direct and efficient means, however, that we possess for the re-establishment of the circulation in these cases, is certainly *artificial respiration*. In this way alone the pulmonary artery and the capillaries of the lungs can be unloaded of the blood that has stagnated in them, and the left side and substance of the heart will be directly and rapidly supplied with red blood. The whole value of artificial respiration depends, however, upon the way in which it is employed. Inflation from the mouth of an assistant into the nostrils or mouth of the sufferer, though objectionable, as air once respired is not well fitted for the resuscitation of the few sparks of life that may be left in the cases in which it is desirable to employ this means, is yet in many

instances the readiest and indeed the only mode by which respiration can be set up; it should, therefore, always be employed in the first instance, or until other and more efficient means can be prepared.

The bellows, if properly constructed for artificial inflation, so that the quantity of air injected may be measured, are no doubt very useful; and if furnished with Leroy's trachea-pipes, or what is better, with nostril-tubes, may be safely employed. About fifteen cubic inches of air may be introduced at each stroke of the bellows, and these should be worked ten or a dozen times in a minute. The lungs should be emptied by compression of the chest before beginning to inflate, and, after each inflation, by compressing the chest and abdomen; but care must also be taken not to employ much force, lest the air-cells be ruptured. But a safe, and at the same time a very efficient mode of introducing pure air into the lungs, is by the elastic expansion of the walls of the chest. This may be effected in various ways; either by means of the split sheet, as recommended by Leroy and Dalrymple (Fig. 170),

Fig. 170.



Split sheet applied: ends knotted.

or else by alternately compressing the chest and abdomen with the hand, and then removing the pressure so as to allow the thorax to expand by the natural resiliency of its parietes, and thus, each time it expands, to allow a certain quantity of air to be sucked into the bronchi. The method recommended by Dr. Silvester, and now adopted by the Royal Humane Society, effects this purpose with great ease and certainty. It is carried out in the following way. The patient is laid on a flat surface on his back, with the head and shoulders slightly raised on a pillow. His arms are then to be grasped just above the elbows, and to be drawn gently and steadily upwards until they meet above the head, in which position they are kept for two seconds; they are then to be turned downwards, and to be pressed for two seconds gently and firmly against the sides of the chest. These movements are to be repeated deliberately about fifteen times in the minute, until natural efforts at respiration are induced, when they are to be discontinued, and the ordinary means to promote circulation and warmth employed. The quantity of air introduced need not be large; for, by the law of the diffusion of gases, if fresh air be only introduced into the larger divisions of the bronchi, it will rapidly and with certainty find its way into the ultimate ramifications of these tubes. This last means of inflation has the additional advantage of resembling closely the natural process of respiration, which is one of expansion from without inwards, and not, as when the mouth or bellows are used, of pressure from within outwards. In one case the lungs are, as it were, drawn outwards, the air merely rushing in to fill up the vacuum that would otherwise be produced within the thorax by the expansion of its parietes; in the other they are forcibly pressed up from within, and hence there is danger of rupture of the air-cells.

Inflation of the lungs with oxygen gas is likely to be of great service in extreme

cases of asphyxia. I have found by experiment that the contractions of the heart can be excited by inflating the lungs with this gas, when the introduction of atmospheric air fails in doing so; and there are cases on record in which resuscitation was effected by inflating the lungs with oxygen, when in all probability it could not have been effected with any other means. In my Essay on *Asphyxia* will be found a case of resuscitation, in which oxygen was successfully employed by Weeks after the asphyxia had continued three-quarters of an hour. Whatever means of resuscitation are adopted, they should be continued for at least three or four hours, even though no signs of life show themselves; and after resuscitation the patient should be kept quiet in bed for some hours.

The danger of the supervention of *secondary asphyxia* after recovery has apparently taken place is much increased, and indeed is usually brought about, by some effort on the part of the patient that tends to embarrass the partially restored action of the heart and lungs. The patient, being to all appearances resuscitated, is allowed to get up and walk home, when the symptoms of asphyxia speedily return. Should symptoms of secondary asphyxia, such as stupor, laborious respiration, dilatation of the pupils, and convulsions, manifest themselves, artificial respiration should be immediately set up, and be maintained, until the action of the heart has been fully restored. In these cases I should, from the very great efficacy of electricity in the somewhat similar condition resulting from the administration of the narcotic poisons, be disposed to recommend slight shocks to be passed through the base of the brain and upper portion of the spinal cord, so as to stimulate the respiratory tracts.

Asphyxia from the *respiration of noxious gases*, such as carbonic acid, is best treated by exposing the surface of the body to cold air, by dashing cold water upon the face, and by setting up artificial respiration without delay, if the impression of cold upon the surface do not excite these actions. There is a peculiar variety of this kind of asphyxia, which is occasionally met with among infants, the true nature of which was pointed out to me by the late Mr. Wakley, who, as coroner, had abundant opportunities of witnessing it, as it is not an uncommon cause of accidental death amongst the children of the poor. It is that condition in which a child is said to have been *overlaid;* the child, sleeping with its mother or nurse, being found in the morning suffocated in the bed. On examination no marks of pressure will be found; but the right cavities of the heart and the lungs are gorged with blood, and the surface is livid, clearly indicating death by asphyxia. That this accident is not the result of the mother overlaying her child, is not only evident from the *post-mortem* appearances, but was clearly proved by a melancholy case to which I was called a few years ago, in which a mother, on waking in the morning, found her twin infants lying dead, one on each side of her. Here it was evident, from the position of the bodies, that she could not have overlaid both. The true cause of death in these cases is the inhalation of, and slow suffocation by, the vitiated air which accumulates under the bedclothes that have been drawn, for the sake of warmth, over the child's head. In such cases as these, resuscitation by artificial respiration should always be attempted if any signs of life be left.

In cases of *hanging*, death seldom results from pure asphyxia, but is usually the consequence, to a certain degree, at least, of apoplexy, and commonly of simultaneous injury of the spinal cord. In these cases, bleeding from the jugular vein may be conjoined with artificial respiration.

If there should be a difficulty in setting up artificial respiration through the mouth or nose as is more especially likely to happen when the patient has been suffocated by breathing noxious gases, or in cases of hanging, tracheotomy or laryngotomy should at once be performed, and the lungs inflated through the opening thus made in the neck.

INJURIES OF THE PHARYNX AND ŒSOPHAGUS.

Wounds of the œsophagus are chiefly met with in cases of cut-throat, in which, as has been already stated in treating of this injury, they occasion much difficulty by interfering with deglutition.

Foreign Bodies not uncommonly become impacted in the pharynx and œsophagus, and may produce great inconvenience by their size or shape. If large, as a piece of money or a lump of meat, the substance may become fixed in the lower

part of the pharynx or the commencement of the œsophagus, which is narrowed by the projection of the larynx backwards, and, compressing or occluding the orifice of the glottis, may asphyxiate the patient at once. If the foreign body go beyond this point, it usually becomes arrested near the termination of the œsophagus. When it is small or pointed, as a fish-bone, pin, or bristle, it usually becomes entangled in the folds of mucous membrane that stretch from the root of the tongue to the epiglottis, or that lie along the sides of the pharynx. In some cases it may even perforate these, penetrating the substance of the larynx, and thus producing intense local irritation, cough, dyspnœa, and suffocation.

The *symptoms* occasioned by the impaction of a foreign body in the food-passages are sufficiently evident. The sensations of the patient, who usually complains of uneasiness about the top of the sternum; the difficulty that he has in swallowing solids; and perhaps the occurrence of an urgent sense of suffocation, lead to the detection of the accident. Should any doubt exist, the surgeon may, by introducing his finger, explore nearly the whole of the pharynx, and should examine the œsophagus by the cautious introduction of a well-oiled probang.

If the impaction be allowed to continue unrelieved, not only may deglutition and respiration be seriously interfered with, but ulceration of the œsophagus will take place, and abscess form either behind or between it and the trachea; or fatal hemorrhage may ensue by perforation or ulceration of neighboring bloodvessels.

It may happen that the foreign body, by transfixing the coats of the œsophagus, seriously injures some neighboring parts of importance. Thus, in a curious case admitted into the University College Hospital, a juggler, in attempting to swallow a blunted sword, by pushing it down his throat, perforated the œsophagus and wounded the pericardium, death consequently resulting in the course of a few days.

The *treatment* must depend upon the nature of the foreign body and its situation. Should it be of large size, blocking up the pharynx so as to render respiration impracticable, it may be hooked out by the surgeon's fingers. Should asphyxia have been induced, it may be necessary to perform tracheotomy at once, and to keep up artificial respiration until the foreign body can be extracted. If it be small or pointed, as a fish-bone or pin, for instance, though it have lodged high up, the surgeon will usually experience great difficulty in its removal, as it becomes entangled between and is covered in by the folds of the mucous membrane, where from its small size it may escape detection; and after it has been removed the patient will experience for some time a pricking sensation, as if it were still fixed. If the impacted body have passed low down into the œsophagus, the surgeon must deal with it according to its nature. If it be smooth and soft, as a piece of meat, for instance, it may be pushed down into the throat by the gentle pressure of the probang. If, however, it be rough, hard, or sharp-pointed, as a piece of earthenware or bone, or a metallic plate with false teeth attached, such a procedure would certainly cause perforation of the œsophagus, and serious mischief to the parts around; under these circumstances therefore, an attempt at extraction should be made by means of long slightly curved forceps, constructed for the purpose.

It occasionally happens that the foreign body has become so firmly impacted in the pharynx or œsophagus, that it cannot be extracted with any degree of force that it is prudent to use without danger of perforating the œsophagus or transfixing the large vessels of the neck; in these circumstances it may become necessary to open the tube and thus remove it. The operation of *pharyngotomy* or *œsophagotomy* is seldom called for; but, if required, it may be performed by making an incision about four inches in length along the anterior border of the sterno-mastoid muscle on the left side of the neck, the œsophagus naturally curving somewhat towards this side. The dissection must then be carried with great caution between the carotid sheath and the larynx and trachea in a direction backwards, the omo-hyoid muscle having been divided in order to afford room. Care must be taken in prosecuting this deep dissection not to wound either of the thyroid arteries, more especially the inferior one, which will be endangered by carrying the incisions too low. When the pharynx or the œsophagus has been reached, a sound or catheter should be passed through the mouth into this cavity, and pushed forwards so that its point may cause the walls to project, and thus serve as a guide to the surgeon. This must then be cut upon, and the aperture thus made in the gullet enlarged, by means of a probe-pointed bistoury, to a sufficient size to allow the removal of the extraneous substance.

CHAPTER XXVI.

INJURIES OF THE CHEST.

WOUNDS of the chest derive their principal interest and importance from the concomitant injury of the lungs, heart, or larger bloodvessels. When the soft parietes alone are wounded, the injury differs in nothing from similar lesions in other parts of the body; except that it is usually slower in healing. This is especially the case when the muscular parietes are furrowed by bullets. If the surgeon be in doubt whether the cavity of the chest have been penetrated or not, he may endeavor to ascertain this point by careful examination with the finger; but he should never introduce a probe; it is better for him to wait and to be guided in his opinion by the symptoms that manifest themselves, rather than, by probing the wound, to run the risk of converting it into what he dreads—a penetrating wound of the chest.

INJURIES OF THE LUNG.

Rupture of the Lung from external violence has occasionally been met with, more commonly with, but in some instances without, fracture of the ribs or other sign of injury to the thoracic walls. The symptoms and consequences of such an injury closely resemble, indeed are identical with, those of a wound of the lung; there being expectoration of frothy blood, pneumothorax, perhaps emphysema and subsequent pneumonia. Though very dangerous, these injuries are not necessarily fatal; but recovery may take place as after an ordinary open wound of the lung.

Wound of the Lung is the most common and one of the most serious complications of injuries of the chest. It may occur without any external wound, from the ends of a broken rib being driven inwards upon this organ, lacerating the pleura and penetrating the pulmonary tissue; most frequently, however, it happens from a penetrating wound of the chest, by stab or bullet.

The *symptoms* of this injury are sufficiently well marked. There is, in the first place, the immediate shock to the system that usually accompanies the infliction of a severe injury; in this case amounting to extreme collapse, the patient at the same time being seized with considerable difficulty of breathing, the respiration being abdominal, followed by much tickling and irritating cough, and the expectoration of frothy bloody mucus, or perhaps large quantities of pure blood. If there be an external opening, the air may pass in and out during the act of breathing; and emphysema, pneumothorax, or pneumonia will speedily supervene. On auscultating the chest immediately after the infliction of the injury, and before there is time for the supervention of any consequences, a loud rough crepitation will be distinctly audible at and around the seat of injury.

Complications.—The principal dangers attending a wound of the lung arise from the bleeding, both external and internal, the occurrence of hæmothorax, emphysema, pneumothorax, pneumonia, and empyema.

1. The *hemorrhage* is usually abundant and often fatal; the patient vomiting or spitting up a large quantity of florid and frothy blood, by which he may be choked. If it do not prove fatal in the early period of the injury by the second day, this bloody expectoration generally ceases in a great measure in the course of forty-eight hours, giving way to sputa of a more rusty character. If the external wound be very free, there may also be copious bleeding from it; but not unfrequently the blood finds its way into the pleural sac rather than through the external aperture, and accumulates in it; and death may arise either from the exhausting effects of this internal and concealed hemorrhage, or from suffocation. Although external hemorrhage to some extent is an almost necessary and invariable accompaniment of a wounded lung, yet I have seen a laceration of that organ three inches in length,

occasioned by the projection of broken ribs, which proved fatal on the seventh day by hæmothorax and pleuritic effusion, unattended by any expectoration of blood, or other positive signs of wound of the lung. The symptoms of this internal hemorrhage, *hæmothorax*, are those that generally characterize loss of blood, such as coldness and pallor of the surface, small weak pulse, and a tendency to collapse with increasing dyspnœa. The more special signs consist in an inability to lie on the uninjured side, with, in extreme cases, some bulging of the intercostal spaces, and an ecchymosed condition of the posterior part of the wounded side of the chest. The most important signs, however, are those that are furnished by auscultation. As the blood gravitates towards the back of the chest, between the posterior wall and the diaphragm, there will be gradually increasing dulness on percussion in this situation, with absence of respiratory murmur; the other portions of the lung, however, admitting air freely.

An ecchymosis of the loins described by Valentin, and noticed by Larrey and others, occasioned by the filtration of blood through the wound or rent in the pleura costalis into the areolar tissue of the chest, has been looked upon by some surgeons as pathognomonic of hæmothorax; its importance, however, is secondary to the auscultatory signs, as in many cases it has not been met with, and in others of non-penetrating wounds of the chest it has occurred.

2. *Emphysema*, or the infiltration of air into the areolar tissue of the body, and *pneumothorax*, or the accumulation of air in the cavity of the pleura, are not unfrequent complications of a wounded lung, although not by any means invariably met with. These accidents more commonly occur when the external wound is small and oblique, than when it is large and direct, and not unfrequently happen in those cases in which the lung is punctured by a fractured rib, without there being any external wound. In the majority of cases, emphysema and pneumothorax occur together, but either may be met with separately. The mechanism of traumatic emphysema is most commonly as follows: The costal pleura being wounded and the lung injured, at every inspiration a quantity of air is sucked into the pleural sac, either through the external wound, or, if none exist, from the hole in the lung, thus giving rise to pneumothorax. At every expiration, the air that thus accumulates in the pleural sac, being compressed by the descent of the walls of the chest, is pumped into the areolar tissue around the edges of the wound; and if this be oblique and valvular, being unable to escape wholly through it, it finds its way at each succeeding respiration further into the large areolar planes, first about the trunk and neck, and eventually, perhaps, into those of the body generally. Though this is the way in which emphysema usually occurs, it may be occasioned otherwise. Thus, for instance, I had once under my care a woman, who had extensive emphysema of the areolar tissue of the trunk from fractured ribs, but without any pneumothorax, the lung having been wounded at a spot where it was attached to the walls of the chest by old adhesions, and the air having passed through them into the areolar tissue of the body, without first entering the cavity of the pleura. Hilton has described a form of traumatic emphysema that arises from the rupture of an air-cell or bronchus without any external wound. The air, passing into the posterior mediastinum, and finding its way along the nerves and vessels in this situation, escapes through the cervical fascia which closes the upper part of the thorax, and thus reaching the neck diffuses itself along the sheaths of the arteries and nerves, along which it finds its way into the limbs; its appearance in which is first indicated by its extending along the course of the vessels.

The *symptoms of emphysema* are very distinctly marked. There is a puffy swelling, pale, and crackling when pressed upon, at first confined to the neighborhood of the wound, if there be one externally; if not, making its appearance opposite the fractured ribs, and gradually extending over the upper part of the trunk and neck, to which it is usually limited: in some cases, however, which are happily rare, the swelling becomes more general, the body being blown up to an enormous size, the features effaced, the movement of the limbs interfered with, respiration arrested, and suffocation consequently induced; after death, air has been found in all the tissues, even under the serous coverings of the abdominal organs. In *traumatic pneumothorax* there is a diminution or complete absence of the respiratory murmur on the affected side, with a loud tympanitic resonance on percussion, puerile respiration in the sound lung, and considerable distress in breathing.

3. *Pneumonia* is an invariable sequence of wound of a lung, and constitutes one

of the great secondary dangers of this injury; the inflammation that is necessary for the repair of the wound in the organ having frequently a tendency to extend to some distance around the part injured, and not uncommonly to terminate in abscess. Traumatic pneumonia resembles in all its symptoms, auscultatory as well as general, the idiopathic form of the disease. There are the same crepitation, dulness on percussion, and absence of respiratory murmur as hepatization advances; with rusty sputa, much tinged with blood in the early stages. It differs, however, from the idiopathic form in having less tendency to diffuse itself throughout the lung, and being limited to the neighborhood of the part, and to the side that is injured. Hence it may occur in any part of the lung—the upper and middle lobes—and only invades the base of the organ if that happen to be the seat of wound. It has also a greater tendency than the idiopathic form to terminate in abscess, which, however, is often dependent on the lodgment of some foreign body, such as a piece of wadding or clothing, in the substance of the organ. Traumatic pneumonia is also usually an inflammation of a more sthenic character than that form of the disease which arises from constitutional causes, and is attended by more acute and active febrile disturbance.

4. *Pleurisy and Empyema.*—Whenever the pleura is wounded, whether it be by a fractured rib, or by direct open wound, and whether the lung be injured or not, pleurisy necessarily sets in, and the repair of the injury in the serous membrane is effected by the effusion of lymph, which, in all cases in which the pulmonic pleura is injured, and hence in all cases of wounded lung, causes adhesions between it and the costal pleura, and thus obliterates to a certain extent the serous sac. If this inflammation run too high, if the constitution be unsound, or if blood or a foreign body be lodged in the cavity of the pleura, effusion, often to a very considerable extent, will take place. The effused fluid is usually turbid serum, full of flakes of lymph, which often adheres in large layers to the inside of the chest-wall. It is generally mixed with blood from the wounded lung. This effusion will take place very rapidly, so as to half fill one side of the chest in three or four days. Eventually, suppuration may take place. The existence of these effusions of serum and pus mixed up with lymph and blood, may be recognized by the ordinary auscultatory signs; dulness on percussion and absence of respiratory murmur at the lower and posterior parts of the chest, up to a level that has a gradual tendency to ascend, and that varies according as the patient is upright or recumbent, with ægophony at the upper part of the lung, until at last, the whole side of the chest being filled with fluid, there are complete absence of all breath and voice sounds, with increase of size on measurement, bulging of the intercostal spaces, compression of the lung against the spine; and, if the left pleura be filled, displacement of the heart towards the right side; if the right pleura be the seat of the accumulation, descent of the liver below its normal level. When the pleuritic effusion and extravasation reach such a pitch as this, there is necessarily great dyspnœa, and death will usually speedily ensue.

Collapse of the lung in wounds of the chest, consequent upon the action of the atmospheric pressure on the outside of the organ, has been more frequently spoken about than seen. The chest may be largely opened, and the full pressure of the atmosphere allowed to act on the outer surface of the lung, and yet no collapse of this organ takes place. The lung in such cases may be seen rising and falling at the bottom of the wound. When collapse of the lung occurs in the early stage, it is, I believe, owing to compression by the air sucked into the cavity of the pleura by pneumothorax. In the latter stages, it may be due to compression by hæmothorax or empyema.

The *prognosis* in wounds of the lungs is necessarily extremely unfavorable, but less so than that of similar injuries of most of the other viscera. The danger will depend greatly upon the mode of infliction of the wound and its extent. If the lung be wounded by the sharp end of a broken rib, recovery usually ensues. Punctured wounds of the chest, penetrating the lungs, are always very serious; but here the danger will depend partly on the depth of penetration, partly on the size of the instrument that occasions the wound. The nearer the wound penetrates to the root of the lungs, the greater is the danger from hemorrhage by the implication of the larger vascular trunk. Gunshot wounds of the chest are far more dangerous than stabs, owing partly to the laceration attendant on a bullet-wound, but especially to the lodgment of the bullet or other foreign bodies, that so commonly occurs

in these injuries. Guthrie states, that more than half of those who are shot through the chest die. After the battle of Toulouse, of 106 such cases, nearly half died; and of 40 cases at the Hôtel Dieu, 20 died. Of 147 penetrating gunshot wounds of the chest occurring in the Crimean war in the British army, 120 died; and Mouat and Wyatt state that, of 200 cases of penetrating wounds of the chest occurring in the Russian army at the siege of Sebastopol, and treated at Simpheropol, only 3 recovered. The Russian surgeons, however, do not bleed in these cases, but use digitalis instead. The great danger and principal cause of death in these injuries is unquestionably the hemorrhage that ensues. This may prove immediately fatal if one of the larger pulmonary vessels be divided. As the bleeding is most abundant at and shortly after the receipt of the wound, Hennen states that, if the patient survive the third day, great hopes may be entertained of his recovery. After this period, the chief source of danger is the occurrence of inflammation of the lungs and pleura, the extent and severity of which are greatly increased in gunshot injuries by the frequent lodgment of foreign bodies within the chest. The immediate cause of death at this stage is undoubtedly the accumulation of inflammatory effusion in the pleural cavity, as the direct consequence of the pleurisy developed by the injury. This effusion is often very rapid, and may prove fatal from the fourth to the eighth day. Emphysema is seldom a dangerous complication, though it may become so if very extensive and allowed to increase unchecked.

If both lungs be wounded at the same time, the result is almost inevitably fatal, either by the abundant hemorrhage suffocating or exhausting the patient, or else by induction of asphyxia in consequence of air being drawn into both the pleural sacs, and thus by compressing the lungs, arresting respiration. This, however, does not necessarily result; and there are a sufficient number of cases on record of recoveries after stab or bullet-wounds traversing both sides of the chest, to show that collapse of the lungs and consequent asphyxia does not necessarily result from this double injury, which indeed has also been determined experimentally on animals by Cruveilhier.

The *treatment* of wounds of the chest, implicating the lungs, must have reference to various sources of danger that have just been indicated.

The *local treatment* is of a very simple character. If the wound have been made by a bullet, all foreign bodies that are within reach should be extracted. If there be any difficulty in doing this, it may be necessary to enlarge the aperture and then to remove them; but the surgeon must not go too deeply or perseveringly in search of them, lest he excite more irritation than the foreign body would. Light water-dressing should then be applied, no attempt being make to close the aperture, so that the escape of any extraneous substance that may have been left, or of extravasated blood, may not be interfered with.

If the wound be a clean puncture, without escape of air or much hemorrhage, the edges may be brought together and closed by means of stitches, plasters, and collodion, so that the bleeding may be arrested, and the patient enabled to breathe with more ease. Should the wound be large and deep, blood and air issuing freely through it from the injured lung, it should not be closed, but the patient should be laid on the wounded side, and a piece of water-dressing applied, otherwise emphysema or hæmothorax will certainly occur. In either case, the wall of the chest on the injured side should be fixed by long and broad strips of plaster, an aperture being left between the strips opposite to the seat of injury. Mouat states that the best results have followed this practice in the army.

In wounds of the chest-walls, the *intercostal arteries* usually seem to escape; or at least, if wounded, they do not bleed in a troublesome manner. Should profuse hemorrhage occur from this source, I believe that the only safe mode of arresting it is to open up the wound, and, if necessary, to enlarge it so as to reach the bleeding vessel. Should this fail, compression must be trusted to. An infinity of devices have been recommended for the suppression of this kind of hemorrhage; but they are for the most part more ingenious than useful and but little applicable to practice, and, indeed, the complication is so rare in chest-wounds, that it is needless to describe them.

Wounds of the internal mammary artery are of rare occurrence, considering its exposed situation. They may, however, occur if the chest be penetrated in front through the intercostal spaces or costal cartilages. The danger in these cases is from the hemorrhage taking place slowly into the anterior mediastinum, or one of the pleuræ, without any external bleeding revealing the mischief that is going on

within. If the wound of the vessel be ascertained, an attempt should be made, by enlarging the external aperture, to seize and ligature the bleeding ends, cutting directly down upon them through the injured intercostal space; or the vessel might even be followed beneath one of the costal cartilages, if necessary, by cutting through this. Should much blood have already been extravasated, this must be removed through the external wound, by the introduction of a female catheter, or by the application of a cupping-glass over it, and the case then treated like one of effusion into the chest.

In the *constitutional treatment* of these injuries, the first indication consists in diminishing the quantity and force of the blood circulating through the lungs, and thus, by lessening the impulse of the heart and increasing the tendency for the blood to coagulate in the spongy pulmonary tissue and smaller vessels, to endeavor to arrest the hemorrhage from these organs. The patient must be kept lying on the injured side, and have nothing but ice and barley-water allowed. If the hemorrhage have been very abundant, the collapse and fainting consequent upon the excessive loss of blood may tend to induce a natural cessation of the bleeding, which thus often spontaneously ceases on the supervention of syncope. Should the hæmoptysis, however, continue or return from time to time, what should be done? Here a very considerable discrepancy of opinion exists amongst surgeons; the question at issue being whether venesection should be adopted with the view of restraining the hemorrhage, or the patient be treated by rest, low diet, ice, digitalis, &c. Up to a very recent period, viz., the close of the Crimean war, the most experienced surgeons were unanimous in their opinion, that the patient's safety lies in free and repeated venesection. John Bell, Hennen, and Guthrie, all concur in urging the necessity of free venesection so as to keep down the action of the heart and arteries whenever this rises and the cough or hæmoptysis returns, recourse should be had to the lancet. In the Crimean campaign, Macleod states, that "those cases did best in which early, active, and repeated bleedings were had recourse to." In the official report of the Medical and Surgical History of the War in the Crimea, venesection is advocated with equal decision as a means of arresting hæmoptysis. The writers state: "When hæmoptysis to any considerable or dangerous extent is present, venesection for the rapid induction of syncope seems not only allowable but seems to afford the only chance of safety, and may even require to be repeated." However paradoxical or even irrational it might at first sight appear to endeavor to restrain one hemorrhage by establishing another, yet the practice seemed established as the result of experience, and its good effects could be explained by the sudden induction of syncope by the venesection, giving time for the sealing up of the pulmonary vessels by the coagulation of blood within them.

But, although this was the practice up to a comparatively recent period, the views of military surgeons on this point seem now to have undergone a complete change; and the experience derived from the great war of the rebellion in America and from the Maori war in New Zealand, has led to the promulgation of different doctrines and the adoption of a different line of practice.

In America, venesection appears to have been generally abandoned, and reliance was placed on rest, cold, and opium for the suppression of hemorrhage, and this practice is said to have been generally satisfactory. In New Zealand, Mouat states that bleeding had been almost entirely discarded.

Thus it will be seen that the practice of the modern school of military surgery, with respect to the employment of venesection in the early stages of wounds in the lungs with the view of repressing hemorrhage, is diametrically opposed to that which was adopted, apparently with great success, up to the time of the Crimean war. It is difficult, indeed impossible, for me to explain the cause of the change of opinion and of practice.

In civil practice, I think that, if the patient be young and strong, if the hæmoptysis be not so copious as immediately to threaten life and the dyspnœa great, relief will be afforded, and the chance of severe secondary inflammation lessened by one free venesection. But I do not think that this ought to be repeated unless at a later stage to combat inflammation and to relieve dyspnœa arising from the engorged state of the lung.

If the patient survive the third day, the danger to be apprehended is no longer from hemorrhage, but from inflammation of the lungs and pleuritic effusion. If the inflammation be confined to the lungs, and be attended by much dyspnœa, venesec-

tion will often give much relief. But when the dyspnœa arises from pleuritic effusion, bleeding must necessarily be useless, and in some cases would be decidedly injurious by still further weakening the powers of the patient. The inflammation must also be combated by a rigid diet, and by the administration of salines and antimonials. In fracture of the ribs with wounded lung, the same line of treatment requires to be adopted; but when the accident occurs in elderly people, we may advantageously substitute calomel and opium, or ammonia and senega, for the antimonials.

[The treatment which the author very fairly acknowledges to have been found most successful by military surgeons of the present day, I have found equally satisfactory in cases of penetrating wound of the chest, met with in civil practice. In the later stages, also, the *restorative* treatment, which is now almost universally adopted in cases of idiopathic pneumonia, will generally be found equally efficient in those of a traumatic origin. Perfect rest, quiet, the administration of opium, with plenty of milk, beef tea, and even brandy, if necessary, seem to me, in such cases, more truly antiphlogistic than either bleeding, antimony, calomel, or barley-water.—A.]

If extravasation of blood into the pleura be going on, its further effusion must, if possible, be arrested by the same means that are adopted for the stoppage of external hemorrhage. When the bleeding has been checked in this way, the blood must early be let out from the pleural sac; for, if it be allowed to remain there, it will speedily putrefy, giving rise to extensive formation of pus in the cavity. In order to prevent this occurrence, the wound should be opened freely with a probe-pointed bistoury at the fifth or sixth day after the injury, so that the blood may be discharged. If it do not readily come away, a cupping-glass may be applied over the aperture, and thus it may be withdrawn. Should, however, the hemorrhage continue notwithstanding the employment of the means indicated, Guthrie advises that the wound should be closed, so that the blood that flows into the pleural sac may, by accumulating in this, compress the lungs, and thus arrest the further escape of blood from the wounded vessels; the patient at the same time should be made to lie on the injured side, in order to increase the pressure exercised upon the wounded and bleeding organ. On the sixth or eighth day the chest should be tapped, or the wound opened again, in order to evacuate the extravasation, and prevent its acting as an irritant to the pleura, or, by permanently compressing and condensing the lung, rendering this useless.

In all cases of purulent effusion into the chest, Guthrie advises, with good reason, that tapping should be early performed, in order that the lung may not be drawn down by false membranes in such a manner as to be unable to expand, which would lead to permanent flattening of the side and impairment of respiration.

If any extraneous body, such as a bullet, a piece of wadding, or of clothing, have penetrated too deeply into the chest to be readily extracted through the external wound, it would not be safe to make incisions or exploratory researches, with a view of extracting it; for, though its presence would increase the patient's danger, yet attempts at extraction would not only add to this, but would in all probability be fatal. In many cases, bodies so lodged form an abscess around them, are loosened, and eventually are spat up, or appear at the external wound. In other cases, they remain permanently fixed in the chest, becoming enveloped in a cyst, and so remaining for years, without producing irritation. In this way Hennen states that a bullet has been lodged in the chest for upwards of twenty years; and Vidal mentions a man who lived for fifteen years with the broken end of a foil in his chest, which, after death, was found sticking in the vertebræ, and stretching across to one of the ribs.

The *treatment of emphysema* consists of little in addition to what is called for by the wounded lung. In many cases, indeed, the air becomes rapidly absorbed, without the necessity of any local interference. In others, again, the pressure of a bandage may be required. If, however, the emphysema be so extensive as to interfere with respiration, the external wound must be freely opened, and scarification made into the areolar tissue, so as to give exit to the air. I doubt whether emphysema alone can ever prove fatal. If, however, both sides of the chest be opened, it is possible that the accompanying pneumothorax may so interfere with the due expansion of the lung, as to produce an asphyxial condition that may end in death.

Hernia of the Lung, or Pneumatocele.—Hernia of the lung is an affection of extremely rare occurrence. It consists in the protrusion of a portion of the organ at some part of the thoracic walls, so as to form a tumor under the skin. It has most frequently been met with after an external wound under the cicatrix of which the hernial swelling has appeared; but it has been known to occur from fractured ribs without any wound, and even from violent straining during labor. In these cases it is probable that, the intercostal muscles and costal pleura having been divided or ruptured by the efforts of the patient, and not having united afterwards, the lung has, during expiration, gradually insinuated itself into the aperture so formed, until at last the hernial tumor has appeared.

This protrusion may take place at any part of the thoracic parietes; thus Velpeau has observed it in the supra-clavicular region of a girl; but most commonly it occurs on one or other side of the chest. The tumor may attain a large size; I have heard Velpeau state that he has seen one half as large as the head. It does not appear to shorten life.

The only case that has fallen under my own observation is one that I saw in 1839, in Velpeau's wards at La Charité; and as the signs of the affection were well marked in this case, I may briefly relate it, from notes taken at the time. A man twenty-nine years of age, left-handed, received in a duel a sword-wound at the inner side of, and a little below, the left nipple; he lost a considerable quantity of blood, but did not spit up any. The wound healed in about a fortnight, shortly after which he noticed the tumor, for which he was admitted three months and a half after the receipt of the injury. On examination, an indurated cicatrix about half an inch in length was found a little below, and to the inner side of, the left nipple. On inspiring or coughing, a soft tumor of about the size of an egg appeared immediately underneath the cicatrix, which it raised up; it subsided under pressure, or when the patient ceased to inspire or to cough; and its protrusion might be prevented by pressing the finger firmly on the part where it appeared, when a depression was felt in the intercostal muscles. If the fingers were slid obliquely over the tumor, it yielded a fine and distinct crepitation, exactly resembling that produced by compressing a healthy lung, and the spongy tissue of the organ could be distinguished. On applying the ear, a fine cracking and rubbing sound was distinctly perceived; the tumor was resonant on percussion. The portion of protruded lung did not appear to re-enter the chest on expiration, but was firmly fixed in its new situation. No treatment was adopted in the case, nor does any appear admissible in similar instances.

The only affection with which a hernia of the lung can be confounded, is a circumscribed empyema which is making its way through the walls of the chest. Here, however, the dulness on percussion, and the absence of respiratory murmur and of crackling under the fingers, will readily enable the surgeon to make the diagnosis.

It occasionally happens in extensive wounds of the chest that a portion of the lung protrudes during efforts at expiration. If the wound be free, the protruded lung may return on pressure, or during inspiration. If left unreturned, it soon becomes livid and gangrenous; in these circumstances it may be removed by the knife or ligature; but Guthrie advises that the protruded part should never be separated from the pleura costalis by which it is surrounded at its base, so that the cavity of the thorax may not be opened; the wound must then be closed in the usual way.

WOUNDS OF THE HEART AND LARGE VESSELS.

Injury of the Pericardium.—The pericardium may be injured without the heart being wounded; by stabs, by gunshot violence, or by severe contusions of the chest. In injuries such as these, inflammation is set up, and the ordinary auscultatory signs of pericarditis, such as friction or creaking sounds, with dulness on percussion, are distinctly perceptible. When blood is effused into the pericardial sac, these morbid sounds may be absent; but the heart's impulse is weak, and the circulatory sounds distant, the layer of blood preventing, as Guthrie has pointed out, the contact of the pericardial surfaces, and thus interfering with the production of those sounds which are dependent on this contact.

Wounds of the Heart are generally at once fatal, from the sudden loss of blood

and the severe shock that the patient sustains. There are many cases on record, however, of persons who have walked or run some considerable distance after receiving a wound in the heart, before falling down dead. Ollivier and Sanson have collected twenty-nine cases of penetrating wounds of the heart, which did not prove fatal in the first forty-eight hours after the receipt of the injury. On analyzing these, it would appear that the rapidity of death depends greatly on the direction of the wound and the part of the organ injured. When the wound is parallel to the axis of the heart, it is not so speedily fatal as when in a transverse direction, and wounds of the auricle are more immediately followed by death than those of the ventricle; the irregular contraction of the different planes of muscular fibre that enter into the formation of the wall of the ventricle tending to obstruct the free passage of the blood through the wound, and perhaps to close it entirely. The size of the wound, however, will necessarily influence the result more materially than its direction. Without referring to numerous cases recorded by the older surgeons, there are a sufficient number of instances reported by modern writers to prove that an individual may live for many days, and even recover altogether from the effects of a wound by which the cavities of the heart have been penetrated, although with a foreign body lodged in them. Thus Ferrus relates the case of a man who lived for twenty days with a skewer traversing the heart from side to side. Davis and Steward found a piece of wood, three inches long, in the right ventricle of a boy, who lived five weeks after the accident had happened; Latour records the case of a soldier who lived for six years after being wounded with a musket-ball in the side, and in the right ventricle of whose heart the bullet was found lodged, lying against the septum; and Carnochan relates a case in which the wounded man survived eleven days with a bullet deeply lodged in the substance of the apex of the heart.

From the inquiries of Ollivier it would appear that the right ventricle is more frequently wounded than the left; next, the apex or base of the heart; then the right auricle; and least frequently the left auricle.

The *signs* of an injury of the heart that is not immediately fatal, are not very positive. The hemorrhage, the direction of the wound, the dyspnœa, the extreme anxiety, syncope, and irregularity with smallness of the pulse, indicate the probable nature of the mischief. The most important information, however, is to be derived from auscultation; the occurrence of friction, or some other abnormal sound, with absence of impulse, and increased dulness on percussion over the region of the heart, may point to the seat of the injury.

[The signs of a wound of the heart may be obscured by those of a coexisting lung wound, as occurred in a case which I had the opportunity of observing several years ago. The patient was evidently dying from pleuritic effusion following an incised wound of the chest, and there was no suspicion that the heart was involved, till the autopsy showed a penetrating wound of the left ventricle in addition to a small punctured wound of the left lung.—A.]

Ruptures of the Heart from External Violence, without penetrating wound of the chest, are not of frequent occurrence. Gamgee has, however, collected 27 published cases of this accident. On analyzing these he finds that, in at least one half of the cases, the pericardium was intact; 12 of the ruptures were on the right, 10 on the left side. The right ventricle was ruptured in 8, and the left in 3 cases; whereas the left auricle was torn in 7, and the right only in 4 instances. Death is usually nearly instantaneous, though there are instances on record in which the patient has made some exertion after the rupture had taken place, and has even lived for several hours. In a case of rupture of the right auricle recorded by Rust, the patient survived fourteen hours. In most of the recorded cases, the injury occasioning the rupture was directly applied to the region of the heart. But instances are not wanting in which this organ has been found ruptured through one or both ventricles or in one of the auricles, without any evidence of direct injury in the cardiac region—the patient having fallen upon his head or shoulders, or having been merely thrown forcibly to the ground with serious injury to the lower extremities. In some of these cases, there is reason to believe that the rupture was produced by the spasmodic violence of the contractions of the heart, under the influence of great mental emotion or fear. The only case that has occurred in my practice was that of a man brought into the hospital dead, having fallen from the top of a cart. The right shoulder was bruised, and the clavicle broken—showing clearly that he had pitched on that side: there was no other bruise about the body, or evi-

dence that the wheels had passed over him. On examination, the liver was found extensively torn, in fact smashed, and the pericardium was distended with blood—there being a triangular ragged aperture at the anterior part of the auricular appendage of the left auricle, through which it had escaped.

Wounds of the Aorta and Vena Cava are as fatal as those of the heart itself. Heil has, however, recorded a case in which the patient recovered and lived for a twelvemonth, after receiving a stab that penetrated the ascending aorta.

CHAPTER XXVII.

INJURIES OF THE ABDOMEN AND PELVIS.

INJURIES OF THE ABDOMEN AND ABDOMINAL VISCERA.

Injuries of the abdomen are of frequent occurrence. They may be divided into contusions of the abdomen, with or without rupture of internal organs; into non-penetrating wounds, and into penetrating wounds, either uncomplicated, or conjoined with injury or protrusion of some of the organs contained in this cavity.

Contusions of the Abdominal Walls from blows or kicks usually terminate without serious inconvenience, but in some cases are followed by peritonitis of a very acute character, which may prove fatal.

In other cases, again, the abdominal muscles may be ruptured, although the skin may remain unbroken. A man was admitted under my care into the hospital, having received a blow from the buffer of a railway carriage upon his abdomen. He complained of great pain at one spot; and, on examination after death, we found the rectus muscle torn across without injury either to the integuments or the peritoneum. If the patient live, an injury of this kind is apt to be followed by atrophy of the muscular substance, and perhaps by the occurrence of a ventral hernia at a later period. Occasionally the contusion is followed by abscess in the abdominal wall, which has a tendency to extend widely between the muscular planes. These abscesses should be opened early, lest they burst into the peritoneal cavity and occasion fatal inflammation.

Buffer-Accidents.—A contusion of the abdomen is often associated with *rupture of some of the viscera.* In military practice these internal injuries are met with in the so-called "wind contusions;" in civil practice they commonly result from blows, kicks, the passage of a cart-wheel over the abdomen, or the squeeze of the body between the buffer of two railway carriages. These "*buffer-accidents*" are of common occurrence in hospital practice, resulting usually from the carelessness of railway guards and porters, who, trying to pass between carriages in motion, are caught and squeezed between the buffers. In these cases the most fearful internal injuries occur, often without an external wound. A man was admitted under my care into University College Hospital, in whom the liver, stomach, spleen, and kidneys, were crushed and torn; the heart was bruised, being ecchymosed on its surface, and one of the lungs lacerated, without there being any rupture or bruise of the skin or fracture of the ribs. In this way any of the abdominal organs may be torn or contused, the particular one injured depending on the situation of the blow. The organ that is most frequently crushed in this way is the liver, owing to its large size and the ready lacerability of its structure; the other solid organs, such as the spleen and kidneys, do not suffer so frequently; the pancreas I have never seen injured. Among the hollow organs the stomach most commonly suffers, and it is especially likely to do so if distended by a meal at the time when it is struck. Any portion of the intestinal canal may be lacerated. I have seen the duodenum, the ileum, the jejunum, and the large intestine ruptured in different cases; the mesentery likewise may be torn, and the spermatic cord snapped across.

[The peritoneum may be ruptured without any external wound and without lesion of any other viscus. If the part injured be the omentum or mesentery, death will usually take place very quickly from hemorrhage; if, on the other hand, the laceration affect the parietal portion, the hemorrhage will be comparatively slight, and the

great danger will be from peritonitis, which, in a case under my care, caused death about 20 hours after the reception of the injury.—A.]

The sufferer usually dies in the course of a few hours, or at the utmost at the end of two or three days after the receipt of these severe injuries, from hemorrhage into the abdominal cavity, conjoined with shock to the system. It is seldom that life is prolonged sufficiently for peritonitis to be set up, though this is the chief danger to be apprehended in those cases that survive the more immediate effects of the accident. The shock of itself may, however, prove fatal, though there be but little internal mischief done; thus, I have seen a man die collapsed eight hours after a buffer-accident, in whom no injury was found except a small rupture of the mesentery, attended with but very slight extravasation of blood. The severity of the shock, amounting often to prolonged and complete collapse, is one of the most remarkable phenomena attending these injuries. It is, doubtless, due to concussion of the great sympathetic. The continuance of the shock may be maintained, and its intensity increased, by internal hemorrhage, which, when the solid organs are ruptured, is the most common cause of death. So far as my experience goes, I would say that the shock is most severe in injuries of and about the stomach, probably from lesion of the great solar plexus. Hemorrhage is the most usual cause of death when the liver and spleen are ruptured, and the patient usually dies of acute peritonitis when the intestine has been torn across. It does not follow, however, that these injuries are necessarily fatal. Patients have lived after all the signs of rupture of the kidneys, passing bloody urine, and having circumscribed peritonitis, and, when death has occurred at a later period, cicatrices have been detected in these organs; this, indeed, is nothing more than has been met with in ordinary penetrating wounds of the abdomen. A patient was admitted under my care into the University College Hospital for a severe blow from the buffer of a railway carriage upon the back, followed by hæmaturia and other symptoms of renal injury; on his death from pneumonia nine weeks after the accident, an extravasation of blood, with the marks of recent cicatrization, was found in the left kidney.

Rupture of the liver is by no means speedily or even necessarily fatal. It may be, and usually is so, from great extravasation of blood or of bile; but when this is not largely poured out, the patient may live for some considerable time, though he may eventually succumb to traumatic peritonitis. A man was once admitted under my care into the University College Hospital, who had been crushed between the buffers of two railway carriages. He was collapsed, and apparently moribund, but rallied in a few hours. Two days after the accident, great pain and tenderness in the right hypochondrium were complained of, and dulness on percussion was found to extend as low as the umbilicus. He became jaundiced, and there were symptoms of low peritonitis; these were followed by great swelling of the abdomen, which became tympanitic; the peritonitis continued, and symptoms of intestinal obstruction came on, the dulness increasing, with fluctuation in the flanks. He died on the sixteenth day after the accident, and on examination no less than 240 ounces of bilious fluid, mixed with flakes of lymph, were found in the abdominal cavity; the obstruction being dependent on the pressure of this effusion, and on the matting together of the intestines by lymph. There was a large rent found in the thick border of the liver, which was beginning to cicatrize. Injury over the region of the liver followed by peritonitis and jaundice, and probably occasioning laceration of that organ, may be recovered from. Of this I have had several instances in my own practice. The following is a good example.

A man, about forty years of age, fell from a scaffold to the ground. In falling, he struck violently against a beam, injuring his abdomen on the right side. He was brought to the hospital in a state of collapse, from which he slowly rallied. There was no injury but that to the abdomen, of which he complained much, more particularly over the region of the liver, which was very tense. Peritonitis speedily set in, with great tympanitic distension of the belly, vomiting of bilious matter, and white stools. These symptoms continued many days, and he became jaundiced. As the tympanitis subsided, it was found that there was dulness on percussion in both flanks, and that the fluid, which was evidently extravasated in the peritoneal cavity, rose when he lay on his left side, which he did habitually, to a level with the umbilicus. He was treated with opium, and put on a very mild diet. He gradually but slowly recovered, the vomitings becoming less frequent and eventually ceasing, and the fluid in the abdomen becoming slowly absorbed, bile at the same

time appearing in the motions; but the tenderness over the region of the liver continued up to the time at which he left the hospital, well, nearly two months after the accident. In this case the long and severe collapse, the seat of pain and injury, the peritonitis, the bilious vomitings, and the white stools, all pointed to serious injury of the liver and the intestines, and rapid intra-abdominal extravasation could only be accounted for by rupture of that organ.

The *symptoms* of an internal abdominal injury are often extremely equivocal, and will necessarily vary according to the organ injured.

If the *spleen* have been lacerated, there will be all the effects of severe shock of the system, accompanied by those of internal hemorrhage: coldness, and pallor of the surface, a small and feeble pulse, anxiety of countenance, and great depression of the vital powers, with pain at the seat of injury, and perhaps dulness on percussion from extravasated blood; symptoms that speedily terminate in the death of the patient.

If the *kidneys* be injured, the patient will commonly experience a frequent desire to pass urine, and this will be tinged with blood, often to a considerable extent. After the discharge of blood ceases, the urine will become albuminous, and may continue so for a great length of time. On examining such albuminous urine under the microscope, it will generally be found that it contains a few blood-corpuscles and possibly some casts of tubes, with mucus and epithelial scales, showing the existence of inflammatory action in the kidney. It is a remarkable and important practical fact that, so far as my experience goes, I have never seen albumen in the urine as the result of renal injury unless it had been preceded by blood. The absence of blood from the urine must not, however, be taken as an indication that the kidney is not injured; it may be so disorganized as to be totally incapable of secreting, and consequently no bloody urine finds its way into the bladder. A man was admitted into the hospital under my care for a buffer-injury of the back; he passed urine untinged with blood, but after death his right kidney was found completely smashed by the blow, with an extensive extravasion of blood in the cellulo-adipose tissue around it; here it was evident that the disorganization was so sudden and complete, that no bloody urine had found its way into the bladder. In another case, in consequence of a fall from a window, an elderly man died in the course of an hour, having struck his back and sustained several fractures of the limbs. The left kidney was found ruptured in a starred manner, with extensive extravasation of blood into the tissues around it, but not a tinge of blood in the urine which was retained in the bladder.

If the *liver* have been ruptured, pain over the region of that organ, dulness on percussion from extravasated blood, and great collapse, followed, if the patient live, by diffused traumatic peritonitis, bilious vomitings, white stools, and jaundice, will, with sufficient precision, indicate the true nature of the injury. Bernard has further shown that contusions of the liver are followed by traumatic saccharine diabetes.

When the *stomach* is ruptured, it commonly happens that the nature of the accident is revealed by bloody vomiting; and when the *intestines* have been torn, by the admixture of blood with the stools, if the patient live long enough to pass any. These signs, however, do not occur in all cases. A man was admitted to the hospital under my care, whose abdomen had been squeezed between a cart-wheel and a lamp-post; during the five hours that he lived after the accident, he vomited several times, bringing up a meal which he had taken immediately before. In the vomited matters there was no blood to be seen; but on examination after death it was found that not only the liver and spleen were ruptured, but the stomach was torn almost completely across near the pylorus.

Emphysema of the abdominal wall, and subsequently of the trunk generally, may result from the escape of flatus from wounded intestine into the subperitoneal areolar tissue, and thence into the more superficial areolar planes. When this takes place, the same doughy, puffy, inelastic, crepitating swelling of the subcutaneous areolar tissue, that is met with in the thoracic form of the affection, is observed. The emphysema usually commences in one or the other flank, and may then creep on up towards the axilla, or in front of the abdominal wall.

As a diagnostic sign, this form of emphysema is valuable in those cases in which the intestines have been injured, either without any wound of the abdominal parietes, or, if there be wound, without protrusion of the injured portion of gut. In two of the cases in which I have observed it, this condition was the only positive

sign of intestinal injury. In one case, the transverse duodenum had been ruptured where uncovered by peritoneum, by a buffer-accident; and in the other the rectum and mesorectum had been traversed by a pistol-ball. In both these cases the emphysema was extensive, the flatus having directly passed into the subperitoneal areolar tissue. In other cases it may do so more indirectly by having, in the first instance, passed into the cavity of the abdomen, and rendered that tympanitic, and so, as in the thoracic emphysema of pneumothorax, escaped from this into the cellular tissue at the edges of the wound. In a third case, it occurred as a consequence of tapping the bladder through the rectum. The flatus escaped after the removal of the canula on the sixth day through the small aperture in the walls of the gut into the subperitoneal areolar tissue of the pelvis, thence, through the sciatic notches, down the posterior and outer part of the thighs and flanks.

The diagnosis of abdominal emphysema from thoracic emphysema and from putrefactive infiltration of air into the areolar tissue requires to be made. In the first case it may readily be effected by observing an absence of the signs of thoracic injury, and by the situation of the emphysema in the posterior or lateral abdominal wall, or around the lips of a wound. From putrefactive infiltration with air, the abdominal emphysema is easily distinguished by the cause, and by the absence of low inflammation of the areolar tissue.

The *treatment* of the various injuries of the abdomen that have just been described is of a very simple character. If the symptoms indicate laceration of one of the viscera, little can be done during the state of collapse supervening on the accident, beyond keeping the patient quiet, and employing the means that have been recommended for lessening the effects of shock upon the system. If the patient survive this period, we must guard against the supervention of peritonitis, and limit, if possible, the extravasation of blood into the abdomen, should there be indications of its occurrence, by the employment of treatment that will presently be described.

Wounds of the Diaphragm may be occasioned by stabs or gunshot injury. Sometimes, however, this muscle is perforated by the fragment of a broken rib without external wound. These injuries are necessarily usually complicated with so much visceral injury as to be very generally followed by death, though not in themselves mortal. If the patient survive, the aperture may be blocked up by a false membrane, to which the adjacent lung will probably adhere; and thus the separation between the cavities of the chest and abdomen will be maintained. Should this reparative action not take place, a hernial protrusion of some of the abdominal viscera may take place into the pleural cavity, as will be more fully described when we speak of "diaphragmatic hernia."

Wounds of the Abdomen.—*Wounds of the abdominal wall that do not penetrate the peritoneal cavity*, if uncomplicated with internal injury, usually do well and require to be treated on ordinary principles. If they be incised, and so extensive as to require sutures, the stitches should be introduced through the skin alone, never through muscular or tendinous structures, the union of which could not be effected in this way; the parts injured must also be relaxed by careful attention to position. When they are the result of gunshot injury, they suppurate extensively, and are very slow in healing.

Wounds that penetrate the cavity of the abdomen are of especial interest, on account of the frequency with which they are complicated with peritonitis, and with injury of some of the viscera. They may, for practical purposes, be divided into 1, those that penetrate the peritoneal sac, without wounding or causing the protrusion of any of the contained organs; and 2, those that are complicated with protrusion or wound of some of the viscera.

1. *Penetrating wounds of the abdomen, without visceral protrusion or injury*, are often somewhat difficult to distinguish from simple wounds of the abdominal wall, though the escape of a small quantity of reddish serum may reveal the nature of the accident. In these cases the surgeon should be careful not to push his examination too far, by probing or otherwise exploring the wound, lest he bring about the very injury he is anxious to avoid. The cavity of the peritoneum has often been perforated from front to base by bullet-wounds or sword-thrusts, without there being any sign of visceral injury. In the absence of peritonitis or other signs of mischief, the wound must be treated as a simple one of the abdominal wall, and any complication that may occur must be met in the way that will immediately be described.

2. In a *penetrating wound with protrusion or injury of the viscera*, the risk is necessarily greatly increased; here the chief danger is from peritonitis, induced either by the wound, by the extravasation of the intestinal contents into the peritoneal cavity, or by the accumulation of blood in it. It but seldom happens that death results from hemorrhage in these cases, though this may, of course, occur if any of the larger vessels be injured.

Protrusion of uninjured intestine, mesentery, or omentum may take place through the wound in the abdominal wall. This protruded mass is always of very large size in comparison with the aperture from which it escapes, the sides of which, being overlaid by it, constrict it rather tightly, so as to form a distinct neck to the protrusion. If left unreduced, the mass speedily loses its polish and bright color, becoming dull and livid from congestion; it then inflames, and soon becomes gangrenous from the pressure exercised upon it by the sides of the aperture through which it has passed.

In many cases *the protruded intestine is wounded.* The existence of this further injury will readily be ascertained by the escape of flatus, or of the more fluid contents of the gut. The characters of the wound vary, as Travers has pointed out, according to its size. If it be a mere puncture in the gut, or even an incision two or three lines in length, an eversion or prolapsus of the mucous membrane will take place, so as to close it to an extent sufficient to prevent the escape of its contents. If the aperture be above four lines in length, this plugging of it by everted mucous membrane cannot take place, and then the contents of the bowel are more freely discharged; but, even under these circumstances, there will be a tendency to the protrusion of the membrane, which forms a kind of lip over the edge of the cut.

A wounded intestine which does not protrude, but remains within the peritoneal sac, presents the same conditions. In these cases, however, there is the additional danger of the extravasation of the intestinal contents into the peritoneal cavity. This *extravasation of feculent matter*, unquestionably one of the greatest dangers that can occur in wounds of the abdomen, inasmuch as by its irritating qualities it gives rise to and keeps up the most intense peritonitis, takes place less frequently than might be expected. For this there are several reasons. In the first place, we have already seen that, if the wound in the gut be below a certain size, there is a natural tendency to its occlusion by eversion of the mucous membrane into it. Besides this, it must be borne in mind that, though in ordinary language we speak of the "cavity" of the abdomen, there is in reality no such thing; there being no empty space within the peritoneal sac into which extravasated matters could fall, but the whole of the visceral contents of the abdomen being so closely and equably brought into contact by the pressure of the abdominal muscles and of the diaphragm, that it requires some degree of force for the intestinal contents to overcome this uniform support, and to insinuate themselves between the coils of contiguous portions of intestine. The influence exercised by the continuous pressure of the abdominal walls upon the intestinal contents, is well shown by the greater facility with which these escape from a portion of wounded intestine that has been protruded, than from one that is still lying within the abdomen. In the former case, feces will escape from a much smaller aperture than in the latter instance, in consequence of the gut not being supported on all sides by the uniform pressure to which it is subjected within the abdomen. It is seldom, indeed, that feces are extravasated from gut that is not protruding, unless it be very full at the time of the injury, or the wound in it be very extensive. The influence of the equable pressure of the abdominal contents in preventing the escape of the feces was well illustrated in a case in University College Hospital, of a man who was shot through the abdomen. The intestines, which contained much feculent matter, were traversed by the bullet in four places. He lived twenty-four hours, and yet no feculent extravasation took place. In another case to which I was called, that of a young gentleman who had been accidentally shot through the abdomen with the ramrod of a horse-pistol, the descending colon was cut completely across, and the small intestines perforated in two places, and yet no extravasation had taken place, though he survived the accident two days.

Blood is extravasated more readily than the intestinal contents in wounds of the abdomen. This is in a great measure owing to the *vis à tergo* existing in an artery of moderate size, such as one of the branches of the mesenteric, being sufficient to overcome the equable pressure and support of the abdominal walls.

These extravasations, whether of feces or of blood, when once formed, have little tendency to diffuse themselves, but become localized in the neighborhood of that part from which they were originally poured out, owing, in the first instance, to the surrounding pressure, and, at a later period, to the deposit of plastic matter between the folds of intestine and neighboring viscera. In this way, the diffusion of irritating matters through the abdominal cavity being prevented, the likelihood of the occurrence of wide-spread and fatal inflammation is much diminished.

The existence of these extravasations may, in many cases, be recognized by dulness on percussion around the wound, by the localized swelling to which they give rise, and sometimes by their escape through the external aperture.

Treatment.—In the treatment of penetrating wounds of the abdomen, we must first consider the management of the injured parts; and, afterwards, the prevention or cure of the consecutive peritonitis.

If the wound *have not implicated any of the abdominal viscera*, it must be closed by relaxing the abdominal muscles by position, by introducing a few points of suture through the integuments, if it be extensive, and by applying a compress and plaster, supported by a bandage. The patient should then have a full dose of opium given him; about two grains of solid opium or forty minims of the liquor sedativus, which must be repeated in from four to six hours, so that the effects may be kept up. I prefer in these cases the solid opium, of which as much as from six to eight grains may be given in the twenty-four hours. He should then be kept perfectly quiet in bed, and no nourishment given for a few days, except barley-water and ice. The bowels should not be opened by aperient medicine, lest abdominal irritation be set up, but oleaginous enemata may be administered at the end of a week or ten days.

If *the intestine be wounded but not protruding*, we must endeavor to limit the peritonitis that will ensue, and also to prevent feculent extravasation. With this view, the patient should be laid on the injured side with the wound dependent, so as to allow the feces to escape through it, if disposed to do so. If the injury be about the umbilicus, he must lie upon his back with the knees drawn up and bent over a pillow. Opium must then be administered in the full doses already indicated, and repeated in grain doses at least every fourth or sixth hour, so that the system may be kept well under its influence. The value of opium in these cases is very great; it not only seems to moderate the inflammation that takes place in the peritoneum, but is of the greatest utility in preventing extravasation of feces. This it does by arresting the peristaltic movements of the intestine, and thus, by keeping it from change of position, lessening the chance of the escape of its contents. This arrest of the intestinal movements also tends greatly to the closure of the wound. Travers has shown experimentally, and his investigations have been confirmed by subsequent observations on the human subject, that wounds of the intestines are closed by lymph that is thrown out, not only from the contiguous peritoneal surfaces of the part actually injured, but from that of neighboring coils; so that the aperture in the gut becomes permanently glued and attached to the structures in its vicinity. In order that this process should take place, it is necessarily of the first importance that the movements of the bowel be paralyzed; and it is a beautiful provision of nature that the very inflammation which closes the wound, arrests that peristaltic action, the continuance of which would interfere with its agglutination to, and closure by, the neighboring parts. Until, therefore, the necessary degree of inflammation to effect this is set up, the intestinal movements must be arrested by opium.

If *extravasation of feculent matter* have taken place into the cavity of the abdomen, an attempt may be made to facilitate its escape by removing the stitches and plasters from the external wound, and placing the patient on the injured side, so that this may be in the most dependent position; should the lips of the wound have already become adherent to one another, they may even be gently and carefully separated by the introduction of a probe, and in this way an outlet afforded for the effused matters.

When *a portion of intestine or of omentum has protruded*, it should be replaced as speedily as possible, before strangulation has occurred to occasion gangrene of the protruded mass. In order to effect reduction, the abdominal muscles should be relaxed by bending the thigh upon the abdomen, when the surgeon may gradually push back the protrusion by steady pressure upon it; he must not, however, employ any force, nor any rough handling of the exposed and delicate parts; but if it be

found that their return cannot readily be effected, owing to the constriction of the neck of the tumor, the aperture through which they have escaped must be carefully enlarged in a direction upwards, by means of a probe-pointed bistoury, or a hernia-knife guided by a flat director. The incision necessary to enlarge the opening sufficiently to admit of reduction, need not exceed half an inch in length. In replacing the protruded parts, whether by the aid of incision or not, care must be taken that they are fairly put back into the cavity of the abdomen, and not pushed up into the sheath of the rectus, or into the subserous areolar tissue lying before the peritoneum; an accident that would be fatal by allowing the constriction of the neck of the protrusion to continue unrelieved. In effecting the return, the surgeon should not push his finger into the cavity of the abdomen, but must content himself with simply replacing the protruded gut, or omentum, and allowing it to remain in the immediate neighborhood of the wound in the abdominal wall, to which it will contract adhesions; and through which its contents may escape, in the event of any sloughing action being set up in it. If the protrusion be inflamed, it must equally be replaced without delay; but should the intestine have become gangrenous from continued constriction and exposure, no attempt at reduction should be made, but an incision must be carried through it, so as to allow the escape of feces, and the formation of an artificial anus. If the protruded omentum be gangrenous, it must be excised on a level with the peritoneum, to the aperture in which that portion lying within the abdomen will have contracted adhesions.

If *the intestine that protrudes be wounded*, the treatment of the aperture in the gut will call for special attention; and surgeons have been somewhat divided as to the line of practice that should be pursued in such a case. The question that has been left open is, as to the propriety of stitching up the wound of the intestine. Scarpa and S. Cooper were opposed to this practice, on the ground that it does not prevent extravasation, and that the stitches produce irritation by acting as foreign bodies. They proposed to return the wounded gut, taking care, however, to leave the aperture in it to correspond with that in the abdominal wall, so that an artificial anus might be established by the cohesion of the edges of the openings to one another, this adhesion preventing extravasation. To this practice the great objection exists, that extravasation will probably occur before there has been time for the effusion of lymph, and the agglutination of the contiguous surfaces; besides which, it is impossible to secure the necessary correspondence between the two apertures, the wounded gut being very liable to alter its position after it has been replaced. It has also been found by experience that one of the objections urged against the employment of a suture, that it cannot prevent the escape of feculent matter, is not valid. If it be properly applied, it may effectually do so, as was shown by a successful case under my care, the details of which were published in the *Lancet* for 1851. That the stitches act as sources of irritation to any serious extent, is also doubtful. Travers found by experiment that when a wounded gut was sewn up, and returned into the abdomen, the sutures quickly became bridged or coated over with a thick layer of lymph, and gradually ulcerating their way inwards, at last dropped into the cavity of the intestine, being discharged *per anum*, and leaving a firm cicatrix at the point to which they had been applied. For these various reasons, Guthrie, Travers, and other surgeons of experience, advocate the practice of stitching up the wound in a protruding intestine in suitable cases, with which opinion I entirely agree. It is, however, evident that no positive and unvarying rule can be laid down that is applicable to all cases. Much must depend on the nature, causes, and extent of the wound in the gut. If it be very large and transverse, the result of gunshot violence or other contusing force, no suture can be of any service; for, not only might it be difficult to bring the edges together, but they would probably not cohere to one another, nor to the abdominal wall. If, however, the wound be a punctured or incised one, of moderate extent, the case is different. Much will also depend upon the way in which the sutures are applied. They should be introduced by means of a fine round needle, armed with sewing silk, in such a way that the peritoneal surfaces on each side of the wound alone are brought into contact, as adhesion takes place solely between them, the wound in the other structures of the gut filling up by plastic deposit. It has been recommended that the needle should penetrate the peritoneal and areolar coats only, no muscular tissue being taken up in it, lest retraction of the included fibres, by dragging upon the stitches, might reopen the wound. This advice, however, it is extremely difficult to follow.

The safer plan is doubtless to carry the suture through the whole thickness of the gut, bringing the stitches out at about one-sixth of an inch from the edge of the cut, in such a way that the serous surfaces are drawn into apposition (Fig. 171). The kind of suture that should be used is the "glover's stitch." When the lips of the wound have been nearly brought into apposition in this way, it has been proposed to leave the end of the thread hanging out of the aperture of the abdominal wall, and to withdraw it when it becomes loose; but I think it better not to leave it, as it might induce great irritation, acting like a seton in the peritoneal cavity. The ends, therefore, should be cut close to the knot, when the suture will eventually become covered with lymph, and find its way into the inside of the gut by ulcerating through the muscular and mucous coats.

Fig. 171.

Application of suture to wounded bowel.[1]

Should the aperture in it admit of being thus closed, the protruded portion of the intestine must be reduced, having previously been properly cleansed with a little lukewarm water. Should, however, the protruded gut be too extensively torn, and especially if it be lacerated by gunshot injury, it would be useless to stitch it up, and it must be gently and carefully reduced. The reduction must be effected in the way that has been already described, the surgeon being especially careful not to push the wounded coil of intestine far into the abdomen, but to leave it close to the external orifice, so that, in the event of extravasation occurring, or the stitches giving way, a ready outlet may be afforded. Should the wound in the abdominal wall be extensive, it must be closed by means of sutures and plasters, supported by a bandage, the inferior angle being left open to allow the escape of extravasation. The wound in the peritoneum had better be left; but should it be very extensive, recourse might be had to the practice that was successfully adopted in such circumstances by Ward, of stitching up the aperture in this membrane.

The after-treatment must be conducted in all respects on the same principles as in the case of an intestine wounded without protruding. Care must be taken, by attention to the position of the patient, and by the free administration of opium, to keep the bowel as quiet as possible near the external opening; the urine should be drawn off twice in the twenty-four hours, and no purgative whatever administered, lest, by the excitation of peristaltic action, adhesion be disturbed, and extravasation take place. After the lapse of six or eight days an enema may be thrown up, and repeated from time to time. No food should be allowed for the first three days, during which time ice and barley-water should be freely taken; after this, beef-tea, and light food that leaves no solid residue, may be given. It is of great importance that no solid food should be administered for at least two or three weeks after the occurrence of the injury. In a case of wound of the intestine which was under my care, the patient, who was progressing very favorably, and eventually recovered, nearly lost her life by eating the pulp of an orange on the tenth day.

Traumatic Peritonitis is the great danger to be apprehended in all serious injuries of the abdomen, and it is by inducing this that extravasation of feces or of blood so frequently proves fatal. It is true that a certain degree of inflammation of the peritoneum is necessary for the healing of the abdominal wounds, but it must be limited in extent and plastic in character. It is the more diffuse form of peritonitis, attended by the exudation of turbid serum and shreddy ill-conditioned lymph, that is so speedily fatal. In these cases, we meet with the ordinary symptoms of the idiopathic form of this affection; uniform tenderness about the abdomen, but more particularly in the neighborhood of the injury, with occasional stabbing pains, followed by tympanitic distension, vomiting and hiccup, a small, quick, hard pulse, often assuming a wiry incompressible character, with considerable pyrexia, and great anxiety of countenance. The traumatic peritonitis will set in and run its course with great rapidity. In a case in University College Hospital, already alluded to, of bullet-wound of the abdomen, the patient lived twenty-four hours. Two or

[1] [This figure, which is otherwise correct, represents the "interrupted" and not the "glover's suture."—A.]

three pints of serous effusion with much puro-plastic matter were found; and great reddening of the whole of the visceral and much of the parietal peritoneum had ensued. In another case of rupture of the ileum, the consecutive peritonitis proved fatal in about thirty hours after the accident. This extreme rapidity in its course and fatal termination, distinguishes traumatic from idiopathic peritonitis. In some cases, however, the disease assumes a more chronic form; and in some instances recovery takes place. In these less acute forms of the disease, where life is prolonged for many days or several weeks, effusion of dark or turbid serous fluid takes place in the peritoneal cavity. As this inflammatory extravasation increases, dulness on percussion will manifest itself—usually first on the flanks, and then gradually extending forward until it may occupy a great extent of surface in the abdomen.

In the *treatment* of this disease, we must be guided by the character of the inflammation. If it be of a sthenic form, and the patient young and robust, he should be bled freely in the arm, and have leeches abundantly applied over the surface of the abdomen; a pill, composed of two grains of calomel and one grain of opium, may then be administered every sixth hour, or oftener if the patient be not influenced by the narcotic; and rigid abstinence from all except ice and barley-water should be enforced. If the peritonitis be the result of a wounded intestine, it is safer to omit the calomel, using instead mercurials to the inside of the thighs, but giving opium freely. When the peritonitis occurs in an old or feeble subject, our principal trust must be in the administration of opium and in free leeching of the abdomen, followed perhaps by a blister, which may be dressed with mercurial ointment. In these cases, however, early support will be required, with perhaps the administration of wine or stimulants. The inflammatory extravasation will gradually be absorbed under the influence of the calomel, aided by blisters.

[In cases of traumatic peritonitis, I have found the tincture of veratrum viride, given in doses of 3 or 4 drops every three hours, very useful in diminishing the rapidity of the heart's action and the force of the circulation. The effect of the remedy must of course be very carefully watched, to guard against a poisonous impression.—A.]

INJURIES OF THE PELVIC VISCERA.

Bladder.—*Rupture of the bladder*, from blows upon the abdomen, is not of very unfrequent occurrence. It can scarcely happen when the organ is empty, as it then sinks down under cover of the pelvic bones. But when the bladder is greatly distended, rising high above the pubes, and thinned proportionately to its distension, it may very readily be ruptured, even by very slight degrees of external violence, as by one man rolling over another in a drunken scuffle, or by a person running against a post, or falling out of bed.

The *effects* of this injury vary considerably, according to the part that has given way or been wounded. If the laceration have occurred in those portions of the viscus that are invested by peritoneum, the urine will at once escape into the pelvic and abdominal cavities, and speedily occasion death by the intense irritation and inflammation set up by it. I have, however, seen a case in which, even in these circumstances, the patient survived ten days. If, on the other hand, that portion of the organ have been ruptured which is uncovered by the peritoneum, the urine may infiltrate into the areolar tissue between this membrane and the abdominal wall, and, diffusing itself widely, produce destructive sloughing of the tissues amongst which it spreads. In these cases life may be prolonged for some days, when the patient commonly sinks from combined irritative and inflammatory action. An open wound of the bladder is by no means so dangerous as its subcutaneous rupture. Many patients have recovered whose bladders have been perforated and traversed by bullets, the urine finding a free exit through the apertures, and consequently not tending to extravasate itself. Guthrie relates several cases of this kind; and Thomson saw fourteen cases of this description after the battle of Waterloo, in a fair way of recovery. Thus, although we must look upon this accident as of the gravest character, yet it cannot be considered as being necessarily fatal.

The *symptoms* of a ruptured bladder are sufficiently evident; the injury in the hypogastric region, followed by collapse, by intense burning pain in the abdomen and pelvis, with inability to pass the urine, or, if any have escaped from the urethra, its being tinged with blood, are usually sufficient to point to the nature of the accident. If, in addition, it be found on introducing a catheter that the bladder is

empty, or that but a small quantity of bloody urine escapes, the surgeon may be sure that this organ has been burst. In the case of gunshot injury, the escape of urine which generally takes place through the track of the bullet will afford incontestable evidence of the mischief that has been produced.

In the *treatment* of these cases, the most important indication is the prevention of further extravasation by the introduction of a full-sized elastic catheter into the bladder. This must be tied in, and should not be plugged, but should be left open, or with a vulcanized India-rubber tube attached, so that the urine may dribble away through it as fast as it accumulates. If any sign of extravasation make its appearance externally, free and deep incisions should be made into the part, so as to facilitate the early escape of the effused fluid and the putrid sloughs. I cannot but consider all active antiphlogistic treatment as out of place in these injuries, never having seen the slightest benefit follow its employment. The only chance that the patient has, if once extensive extravasation have occurred, is that there may be sufficient power left in the constitution to throw out a barrier of lymph that will limit the diffuse and sloughing inflammatory action set up; and the prospect of this would certainly not be increased by the employment of depletory measures. There will also be so great a call upon the powers of the system at a later period, after sloughing has fairly set in, that a supporting or even stimulating plan of treatment will rather be required.

Foreign bodies, such as pieces of catheters, tobacco-pipes, pencils, &c., are occasionally met with in the urinary organs, having been introduced through the urethra. In some cases they are soon spontaneously expelled, but more usually they require extraction; sometimes they may be fortunately seized with a small lithotrite or urethral forceps in the direction of their long axis, and thus extracted; but more frequently they require to be removed through an incision made into the bladder. This is more safely done by the median than by the lateral operation of cystotomy.

It occasionally happens that musket-balls, pieces of clothing, &c., have been lodged in the bladder in gunshot wounds of that organ. These speedily become incrusted with urinary deposits, and, giving rise to the symptoms of stone in the bladder, require to be removed by cystotomy, an operation that has proved very successful in these cases, evidently in consequence of the healthy condition of the urinary organs. Dixon has collected from various works the details of fifteen cases, in which balls, that had either primarily entered the bladder, or had found their way into this organ by abscess or ulceration after having been lodged in the neighborhood, were extracted by operation. In ten of these cases the result was successful; in the remaining five no record is made of the termination.

[Foreign bodies may be conveniently and safely removed from the female bladder, in many instances, by means of rapid urethral dilatation without incision.—A.]

Rupture of the Ureter.—Stanley has related a remarkable case in which the *ureter* was ruptured by external violence, and in which the patient recovered; a very large accumulation of fluid forming on the injured side of the abdomen, with considerable circumscribed tumefaction and fluctuation, and which required repeated tapping. In another case, in which the *pelvis of the kidney* was ruptured, a similar collection of urine took place within the abdomen, requiring tapping; as much as six pints being removed at one sitting. On examination after death, which occurred on the tenth week from the accident, a large cyst was found behind the peritoneum, communicating with the pelvis of the kidney.

Wounds of the Organs of Generation in the male may be accidental, occasioned by sharp instruments or gunshot, or may be self-inflicted. When only involving the integumental structures, they present nothing peculiar or differing from similar wounds in other situations, except in the great reparative action that the scrotal or penile integuments possess. Even when the whole of the skin of the part has been cut or torn away, the organ will speedily recover itself. In one curious case under my care, in which a woman had unsuccessfully attempted to cut off a man's penis with a carving knife, the organ, which had had the whole of its integuments torn off from the root forwards, quickly covered itself with a new integument, which speedily assumed the normal soft and supple character natural to the skin of these parts.

When the organ is more deeply wounded, there are two special sources of danger, viz., hemorrhage, and wound of the urethra. The hemorrhage is usually very pro-

fuse. If it proceed from a distinct arterial trunk, such as the dorsal artery or that of the corpus cavernosum, the vessel must be ligatured. If it occur from general oozing from the vascular tissue of the penis, it may be arrested by cold, pressure, or astringents. Pressure is best applied by passing a large catheter into the bladder, and then compressing the organ against this by means of a narrow bandage or circular strips of plaster.

Injury of the genital organs by self-mutilation in cases of sexual mania or melancholia is occasionally met with. In some instances the patient has cut off one testis; in others, the penis; in others, again, the whole of the sexual organs. Injuries such as these present no very special character, and require to be treated on ordinary principles, the great point being of course the restraint of hemorrhage.

Urethra.—*Wound of the urethra* by gunshot injury, or sharp instruments, is a troublesome accident, on account of the liability to urinary infiltration and ultimately to fistula. It may be recognized by the escape of blood from the meatus, and of urine from the wound. The *treatment* consists in the introduction of a gum catheter, which should be tied in; and if the edges of the wound be clean cut, they may be brought together by interrupted sutures.

Laceration of the urethra is an accident that is immediately attended by the most serious symptoms, and remotely followed by the most disastrous consequences. It almost invariably occurs in men employed in building, slipping in walking across an unfinished floor, in such a way as to fall heavily astride upon one of the joists, thus bruising the perineum and rupturing the urethra and other structures lying under the rami and symphysis of the os pubis. The same accident may arise in other ways. Thus I have met with it in a farrier, kicked in the perineum whilst shoeing a horse; and it has been met with as a consequence of laceration by a splinter of bone from a fracture of the ramus of the os pubis.

In these injuries the integuments are usually untorn, but deeply ecchymosed. The extravasation of blood is often considerable, extending into the scrotum, which rapidly swells up and becomes black. It may, indeed, be very serious, arising in some cases from the lacerated structures and the torn superficial or transverse arteries of the perineum; in other instances from the corpus spongiosum, the bulb, or the artery of the bulb. In all cases of lacerated urethra blood will drip from the orifice; and, if the bulb and its arteries have been torn, the hemorrhage from this may be very great, a pint or more of blood being thus rapidly lost, in addition to great accumulations in the perineum and scrotum, distending these parts with coagula and infiltrations.

In consequence of the loss of the continuity of the canal and the compression or plugging of the torn part by the coagula of the extravasated blood, the urine cannot be passed and the bladder gradually fills. If the patient attempt to empty it, only a few drops will issue from the urethal orifice; but he will be seized with a severe burning, smarting pain in the perineum, and the ultimate evils of the injury will be greatly aggravated, for, wherever the urine penetrates, sloughing of areolar tissue will invariably and rapidly ensue. There is this great difference between extravasation of urine from ruptured bladder and from lacerated urethra: in the first case the urine escapes involuntarily from the injured organ; in the second instance, no urine will escape from the torn urethra, unless by a voluntary expulsive effort on the part of the patient. The sufferings of the patient speedily become aggravated by the retention of the urine and the distress occasioned by the distended bladder; and the necessity for relief thus becomes urgent, lest by an involuntary spasmodic effort the urine be pumped widely into the already broken down areolar tissue of the perineum and scrotum.

The ultimate consequences of a lacerated urethra are no less serious than the immediate effects. If the floor only of the urethra have been lacerated, leaving the upper part of the wall of the canal intact, the continuity of the urethra will not be lost, but a permanent traumatic stricture of the worst kind will result. If the urethra have been completely torn across, or slough as a consequence of the injury, obliteration of a portion of the canal may ensue, and incurable urinary fistula will be left in the perineum.

The *treatment* of this injury consists in the early introduction of a catheter into the bladder. If this can be done before the patient has made an attempt at passing his urine, much of the immediate danger of the case may be averted, by the prevention of urinary infiltration. The catheter, which should be an elastic one, must

be left in the bladder for a few days. It should not be plugged, but have a vulcanized India-rubber tube attached for the urine to escape as fast as secreted. If any hardness, throbbing, or other sign of irritation occur in the perineum, free incisions should be made into the part, so as to afford a ready outlet for any urine that may have been effused. If the surgeon find it impossible to introduce a catheter into the bladder, the urethra being torn completely across, he should pass it as far as it will go, and then, putting the patient in the position for lithotomy, make a free incision in the mesial line upon the point of the instrument, so as to make an opening in the perineum communicating with the deeper portion of the urethra; any arteries that bleed freely should be tied. He must then endeavor to pass the catheter inwards into the bladder, through the proximal portion of the injured urethra. This is often extremely difficult. If the floor of the urethra only have been torn, it may be accomplished by keeping the point of the catheter well against the upper wall of the canal; but if the urethra have been completely torn across, it will tax all the skill of the surgeon to direct and pass the instrument into the vesical end of the canal. Should the urine become extravasated, the surgeon must follow its course with free and deep incisions, supporting the strength of the patient at the same time by a due allowance of stimulants and nourishment. If, when the urethra is completely torn across, a catheter cannot be passed, and the urine find a difficulty in escaping, relief not being afforded by the perineal incision, and the bladder becoming overdistended, this organ should be tapped through the rectum, in the way that will be described when we come to speak of diseases of the urinary organs. But tapping through the rectum should not be done before the perineal incision is made.

Vagina and Rectum.—*Foreign bodies* are occasionally thrust forcibly into or impacted in the vagina or rectum. When a foreign body, such as a stick, or a broom-handle, or the leg of a chair, is thrust forcibly up the rectum by a person falling on such a thing, two dangers may result; either extensive laceration of the sphincter and perineum, with hemorrhage; or transfixion of the gut and wound of the peritoneum, with consecutive inflammation of that membrane. The consequences of such an injury present nothing very special, and require to be treated on ordinary principles. If in the fall the foreign body have been forcibly thrust into the vagina, there will be danger of similar injury to the bladder or peritoneum; but the chief danger will result from laceration of the labium, and free hemorrhage from this source. I have several times seen enormous quantities of blood lost from such injuries. This hemorrhage is best arrested by plugging firmly with lint soaked in a solution of the perchloride of iron, and the pressure of a bandage. A variety of things, such as pieces of stick, glass bottles, gallipots, &c., have been introduced and impacted in these canals. Their extraction is often attended with great difficulty, in consequence of the swelling of the mucous membrane over and around them, and the depth to which they have been pushed. In order to remove them, lithotomy or necrosis forceps may be required. In some cases the foreign body will occasion ulceration into the bladder, or it has been found to transfix the wall of the canal in which it is lodged, and, by penetrating the peritoneum, has speedily occasioned the patient's death. A remarkable case of this kind occurred in my practice, in which a cedar pencil, five inches long, and cut to a point, had been forced up by the patient herself, a young woman, through the posterior wall of the vagina into the abdominal cavity. Here it transfixed two coils of the small intestine, and, after a sojourn of eight months, I extracted it by an incision through the anterior abdominal wall, midway between the umbilicus and Poupart's ligament, where its point was engaged in the fascia transversalis. It had occasioned repeated attacks of peritonitis; and, after its extraction, death resulted from that cause.

Laceration of the Perineum.—The perineum is occasionally ruptured during parturition. The extent of the laceration necessarily varies greatly, and influences materially the ultimate issue of the case. In some cases there is merely a slight rent at the fourchette; in others, the whole perineum has given way as far as the sphincter ani; in a third class of cases the sphincter is torn as well; and in a fourth set the rent has extended into the recto-vaginal septum. The worst cases are those in which the perineum has been torn, and the recto-vaginal septum destroyed by sloughing from prolonged impaction of the fœtal head. In such cases the loss of soft tissues and the existence of dense cicatricial bands render complete union by operation very problematical.

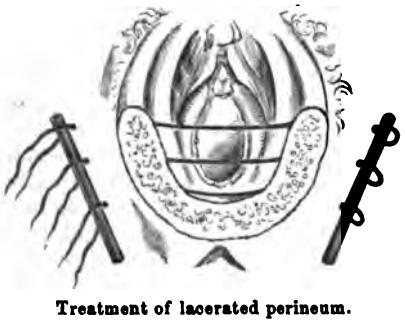
The length of time that has elapsed since the occurrence of the injury is of little consequence. It is as easy to repair a perineum that has been lacerated for ten years, as for ten days. A very serious evil arising from ruptured perineum is the loss of support to the pelvic viscera, and the consequent liability to prolapsus of the uterus or of the vaginal wall. When the sphincter or the recto-vaginal septum has given way, incontinence of feces to a greater or lesser extent is the consequence, and the parts are from this cause liable to excoriation; and not unfrequently the rectal mucous membrane becomes prolapsed or hæmorrhoidal.

The *treatment*, which is purely operative, consists of a plastic procedure, having for its object the bringing together and the union by adhesion of the opposite sides of the rent. The extent and difficulty of this operation, and its prospect of success, will depend on attention to several points, but also, as is the case with most plastic procedures, on the state of the patient's health. This should be brought up to the best standard before the surgeon proceeds to operate: all local irritations should be removed, piles or prolapsus ani tied, and the parts brought into as healthy a state as possible. When the laceration is of limited extent and recent, union may usually be effected by bringing and keeping the thighs together immediately after its occurrence. Should the laceration not extend into the sphincter ani, it may usually readily be repaired by paring the edges freely, and passing two deep quilled and four superficial sutures, so as to bring the opposite sides together.

When the laceration is very extensive, extending through the perineum, the sphincter ani, and the posterior wall of the vagina into the rectum—in fact, tearing through the recto-vaginal septum—more energetic and careful treatment will be required. The following is the mode of performing the necessary operation.

The bowels having been well cleared out, the patient should be placed in the position for lithotomy. The upper wall of the vagina being drawn out of the way by means of a "duck-billed" speculum, the edges and sides of the rent must be freely and deeply pared in a horse-shoe shape, so as to leave a raw surface about an inch in width. The greatest care must be taken to remove every particle of mucous membrane and integumental structure, not only from the sides of the fissure, but also from above the upper angle of it, in the recto-vaginal septum, and from the anterior part of this. This is more commonly done by means of vulsellum-ended forceps. Any portion of these structures that may be left behind, however minute, is of course an obstacle to union, and will either interfere completely with it, or leave a fistulous opening in its site. The sphincter ani should then be freely divided on each side of the coccyx, as recommended by Brown, in order that its action may be paralyzed and all tension of the part removed. Three points of quilled whip-cord suture (Fig. 172) should then be passed deeply through the freshened sides of the laceration, and the edges brought together by a few points of interrupted suture. The deep sutures are best introduced by long nævus needles. The one nearest the anus should be passed first; and if the recto-vaginal septum be involved in the rent, it must be dipped into the freshened surface of this part so as to draw it well forwards and against the new perineum. The sutures should be introduced at a distance of one inch from the cut edge, should pass about three-quarters of an inch in depth, and be brought out on the other side at the same distance from the freshened surfaces as that at which they entered.

Fig. 172.



Treatment of lacerated perineum.

The best material for the deep sutures is strong whip-cord well waxed, or iron wire. I now generally give the preference to the wire as less irritating. The best material for the superficial sutures is thin annealed silver wire. In one case in which I operated, I applied it in the continuous manner by means of the glover's stitch, and found the parts much more securely and easily held together in this way than by the interrupted suture.

The success of the operation will, to a great extent, depend on the attention bestowed on the *after-treatment*, the mode of conducting which has been laid down

with much precision by Brown. The principal points to be attended to are as follows: Immediately after the operation, a full dose of opium should be given, and followed by a grain every sixth hour, with a view of arresting all intestinal action. The strength should be maintained by abundant nourishment. The patient should be laid on her side, and a catheter, furnished with a long India-rubber tube, retained so as to prevent any dribbling of urine over the raw edges, which would be fatal to their union. The hemorrhage usually ceases when the edges are brought together. If it should continue, the application of a pad and T-bandage, and of ice in the vagina, will generally easily control it. The deep sutures, if of whip-cord, should be left in for three days, as a general rule. In some cases they may even be retained for ninety-six hours; but if any suppuration be set up along their track, they must at once be withdrawn; if of wire, they may be left longer—for six days. The superficial sutures should be left in as long as they produce no irritation; when of silver wire, they may be left undisturbed for eight or ten days. During this period, I have found it advantageous to keep the part covered with collodion. When the sutures are removed, a pad of dry lint, supported by a T-bandage, should be applied. The bowels should not be allowed to act for at least ten or twelve days, lest the freshly-united surfaces be torn through. During the whole of this period the patient's strength must be supported by good diet, and scrupulous attention paid to the cleanliness of the parts.

Plastic operations of this kind should not be performed unless the patient be in a good state of health, that there may be a good prospect of immediate union. The success of the case will at last mainly depend on the extent of laceration, or rather of loss of substance, in the recto-vaginal septum. If this be uninjured, or merely notched as it were, but little difficulty will be experienced in effecting a cure. If, on the other hand, this wall be deeply lacerated, or, still worse, if a portion of it have sloughed away, the greatest difficulty may result in effecting union; and under such untoward circumstances it may happen, that the perineum unites, but that a fistulous opening is still left in the recto-vaginal wall, requiring a future plastic operation for its closure (*vide* Chapter LXIII.).

DIVISION THIRD.

SURGICAL DISEASES.

CHAPTER XXVIII.

ABSCESS.

An *abscess* signifies a collection of pus occurring in any of the tissues or organs of the body. In structure, an abscess consists of an accumulation of pus situated in the midst of, and surrounded on all sides by, a layer of fibrine deposited in and consolidating the neighboring tissues. This lymph, which constitutes the *wall* of the abscess, varies greatly in thickness and consistence; in some cases being scarcely perceptible, in others some lines in thickness and of corresponding firmness, constituting perhaps the principal part of the mass. This wall of "limiting fibrine" is always very vascular, in consequence of the inflammation and congestion of the tissues that enter into its composition. Outside it there is an infiltration of seroplastic matter, and beyond this we reach the healthy tissue.

Varieties.—Surgeons divide abscesses into various kinds, according to the symptoms attending them, their duration, and their cause. Thus they speak habitually of acute and chronic, hot and cold, lymphatic, diffuse, metastatic, and puerperal abscesses.

Acute or *phlegmonous abscess* may be taken as the type of the disease. When it is about to form, the part which has been previously inflamed swells considerably, with a throbbing pulsatile pain; the skin becomes shining, glazed, and of a somewhat purplish red. If the abscess be very deeply seated, the superimposed tissues become brawny and œdematous, without, perhaps, any other sign indicating the existence of pus. As the swelling approaches the surface, it softens at one part, where fluctuation becomes perceptible, and a bulging of the skin covering its summit takes place; this *pointing of the abscess* indicates that it is about to burst and discharge its contents, which it speedily will through a circular aperture formed in the skin. The pointing is an interesting pathological phenomenon, and takes place in the following way.

An abscess, perhaps originally formed deeply in the substance of a limb, enlarges by the extension of the periphery of its wall, and by the simultaneous degeneration into pus of the innermost layers of this structure. As the wall extends, it has a special tendency to approach a free surface, whether that be external or internal, skin or mucous membrane; all the tissues between it and the surface towards which it is progressing being gradually absorbed, or melting into the abscess. It is in this that the *pointing* essentially consists; and the mode in which it is finally accomplished would appear to be as follows. The pressure which the tumor exercises from within outwards causes compression of the vessels, which, passing from the deeper parts, ramify between the summit of the abscess and superjacent skin for the supply of the latter. In consequence of this pressure upon the vessels and interference with the circulation through them, the nutrition of the parts supplied by them is arrested; and these become softened, disintegrated in structure, and less resistant to the progress of the tumor than those tissues which surround it on other sides, and which have not had their vascular supply interfered with, nor lost their normal cohesion. The abscess then naturally makes its way at this, the point of its circumference where it meets with least resistance. As it approaches the surface, the skin at first becomes more or less livid, tense, and œdematous, indicating the interference with its circulation; as the summit of the abscess presses upwards, the overlying skin loses its tension and becomes relaxed; it then sloughs at the most central point, from which the cuticle has previously peeled off, and, the out-

ward pressure of the pus speedily detaching the slough, the abscess discharges itself. Though acute abscesses, if left to themselves, usually run this course and burst through the skin, the mucous or serous surfaces, or even into the interior of joints, yet some collections of pus, if very deeply seated, cannot find their way to the surface, but extend through the areolar planes of the limb in a lateral direction, burrowing and undermining the parts to a great extent; or, if situated in dense and unyielding structures, as in bone, are imprisoned within a case through which they may be unable to penetrate; in other rare instances, the pus becomes absorbed, and the abscess disappears. After an abscess has burst, the cavity usually closes by granulations springing up from within, and by the collapse of its walls; in some cases, however, it does not completely close, but contracts into a narrow canal, forming a sinus or fistula (p. 423).

Chronic abscesses are of very common occurrence. The tissue in the vicinity of a piece of dead bone being irritated by its presence, or a gland or some portion of the subcutaneous areolar tissue having become indurated, tender, or subacutely inflamed, at last slowly and without any constitutional symptoms, or much appearance of local disturbance except the swelling, softens and breaks down into a somewhat thin, flaky, curdy puriform fluid, though in other instances the pus is perfectly healthy. These abscesses do not readily point, but often extend laterally, burrowing for a considerable distance from their original seat. In other cases they become circumscribed by a thick and dense wall of fibrine, through which it may be extremely difficult, and perhaps impossible, to detect fluctuation; the disease then simulating a solid tumor. The duration of these chronic abscesses without opening is often very remarkable, even when situated in soft parts. I have seen large chronic abscesses, in the iliac fossa and groin, perfectly stationary for nearly two years. When situated in denser structures, as in the substance of the breast, the wall may become so dense as to resemble a cyst, and the disease will continue in the same state for a great length of time. In the bones, abscesses may exist for an indefinite period.

Cold, *lymphatic* or *congestive abscess* occurs not unfrequently with but slight precursory local symptoms, and indeed not uncommonly without any at all. The patient, who has usually been cachectic, and has suffered some time from general debility, feels slight uneasiness in the groin, iliac fossa, or axilla, and finds sud denly a large fluctuating tumor in one of these situations; there is perhaps no pain in the part, and no discoloration of the skin, but the fluctuation is always very distinct, the limiting fibrine being in small quantity. On opening such an abscess as this, there will usually be a copious discharge of thin unhealthy pus, which, when examined under the microscope, will be found to contain ill-developed, withered cells; in some cases, the contents appear to be a clear semi-transparent or oily-looking matter, probably sero-plastic effusion.

Diffuse abscess forms rapidly in the areolar tissue, as the result of diffuse inflammation. There is no limiting fibrine, and hence the pus often spreads widely, producing extensive destruction of parts before it is discovered. A particular variety of this form of abscess is the *puerperal*, occurring in women after parturition in various parts of the body, especially in the iliac fossa, in the areolar planes of the thigh or in the joints, and in the adipose tissue of the orbit, often destroying the globe of the eye. To these forms of the disease the *metastatic abscesses* are closely allied. They commonly occur in connection with phlebitis and pyæmia, are very numerous, and are met with in the substance of organs as well as in the areolar tissue and joints. The last three species of abscess are varieties of the acute form.

Tympanitic or *emphysematous abscess*, which contains gas as well as pus, is occasionally met with in the neighborhood of the mucous canals, chiefly at the anterior and lateral parts of the abdominal walls, and about the sacrum. Sometimes the communication with the intestine is very free; in other cases it is not so evident. These collections are often perfectly resonant on percussion, the air being above, the fluid below; and sometimes gurgling is very distinct in them.

Situation, Size, &c.—Abscesses are met with in all *regions* of the body, but more especially where the areolar tissue is abundant, and the absorbent glands are numerous. They may occur at any *period of life*, from the earliest infancy to old age. I have opened a very large abscess in the axilla of a child about a fortnight old. Their *size* varies from that of a pin's point to a tumor containing a pint or more of pus. In some cases, when very large, they are *multilocular*, the different cysts being

Fig. 173.

Large lumbar abscess extending down the leg.

connected by narrow channels of communication; in this way I have seen a large abscess extending from the lumbar vertebræ through the iliac fossa down the thigh, the ham, and the leg, until at last it was opened by the side of the tendo Achillis, forming five or six distinct cysts, communicating with one another by contracted channels (Fig. 173).

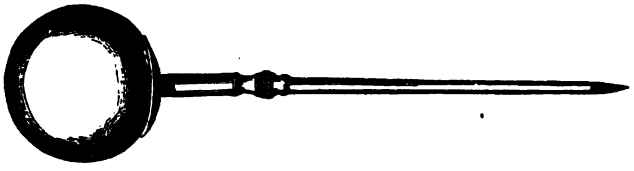
Effects.—The *pressure-effects* of an abscess are often important. By compressing the nerves of a part, it may give rise to very severe pain and spasm at a distance from its seat; and in this way, in some apparently neuralgic affections, it has turned out that the pain has been occasioned by the pressure of an abscess on the trunk of a neighboring nerve. When the bloodvessels come into relation with an abscess, they usually become coated by a thick layer of lymph, which guards them from injury. In some cases, however, they become obliterated by the conjoined effects of the pressure and the inflammation, in which they as well as the adjacent tissues partake. In other cases, more particularly in strumous and cachectic individuals, the bloodvessels, not having been guarded by the protecting lymph, have ulcerated and burst into the cyst of the abscess, occasioning sudden and dangerous or even fatal hemorrhage. It is seldom, however, that a large artery or vein pours its contents into an abscess that has not been opened. These occurrences have chiefly taken place in the neck, in which situation both the carotid artery, as in a case described by Liston, and the internal jugular vein, have opened into the cyst of an abscess. The various mucous canals, especially the trachea and the urethra, may be injuriously compressed by neighboring abscesses; so also bones may become necrosed, and joints inflamed and destroyed, from the same cause.

Diagnosis.—The diagnosis of abscess, though usually easily made, at times requires attention. The surgeon believes that an acute abscess is about to form when, after rigors and some modification of the inflammatory fever, he finds the local signs characteristic of the formation of pus; more especially a throbbing pain in the part, with softening of any induration that may have existed, and œdema of the areolar tissue covering it. His suspicion is turned into certainty, and he knows that an abscess has formed, when, after the occurrence of these symptoms, fluctuation can be felt, and the other signs manifest themselves. The fluctuation may, however, readily be confounded with the undulatory sensation communicated by some tissues from the mere infiltration of sero-plastic fluid into them, or even without this, from their natural laxity, as is sometimes the case in the areolar tissue of the nates and thigh in persons of lymphatic temperament. This, indeed, is a difference of degree rather than of kind; as pus would make its appearance in the course of a few hours, if the tumor were left to itself. The mere occurrence of fluctuation, however, is not of itself sufficient to determine more than that a fluid exists in the part. The question necessarily arises, is this fluid pus? In the majority of instances, the history of the case, the character of the pain, the previous existence and the continuance of symptoms of inflammation, enable the surgeon to answer in the affirmative. But if there be obscure evidence only of inflammation having existed, and if the swelling be of long standing, the fluctuation being perhaps deeply seated and indistinct, the safer plan will be for the surgeon to introduce an exploring needle, and to see what the true nature of the fluid is; by this simple means many embarrassing mistakes in diagnosis may be avoided.

The tumors with which abscesses may be confounded, are those *soft solid growths* in which there is a high degree of elasticity, giving rise to a species of undulation, as in some kinds of encephaloid tumor; so also *fluid tumors* of various kinds, such

as cysts and enlarged bursæ, may be confounded with abscess. In these cases the previous symptoms, the situation, and the general appearance and feel of the tumor, will usually enable the surgeon to effect a ready diagnosis; but should any doubt exist, the exploring needle or trocar must be introduced, when, if pus be present, a drop or two will escape. Coxeter's "suction-trocar" (Fig. 174) is of especial

Fig. 174.



Suction-trocar.

service in cases in which it is desirable to withdraw some of the contained fluid for closer examination. The diagnosis of an abscess having pulsation communicated to it by a subjacent artery, from an *aneurism*, will be discussed when we come to speak of that disease. It may be well to mention that the pains occasioned by the pressure of some forms of chronic abscess upon neighboring nerves have been mistaken for rheumatism or neuralgia.

Prognosis.—Abscesses vary greatly in danger, according to their nature, size, situation, and cause, and the constitution of the patient. The chronic form is usually attended by more risk than the acute and the diffuse. The puerperal and pyæmic are especially hazardous to life, being generally associated with a bad state of the blood. The large size of some abscesses is an element of great risk, occasioning not only a very abundant discharge of pus, but likewise great constitutional irritation when they are opened. Abscesses that are situated in the neighborhood of important organs, as about the neck of the bladder, or in the anterior mediastinum, are necessarily much more hazardous from the peculiarity of their situation than those which are met with in less important regions. The cause of the abscess also influences the result; if it be a piece of dead bone that can be removed, the discharge will speedily cease on its being taken away, but if it be so situated that it cannot be got rid of, it will, by acting as a continuous source of irritation, keep up a discharge that may eventually prove fatal. The constitution of the patient influences our prognosis. Such an amount of discharge as would inevitably prove fatal in a cachectic system, may influence a sound one but very little; so also, the wasting effect of an abscess is better borne about the middle than at either of the extreme periods of life.

Treatment.—The treatment of abscess presents three points requiring attention: The first object should be to prevent the formation of matter; the next to take steps for its evacuation when formed; and the last, to endeavor to close the cavity that results.

In order to *prevent the formation of matter*, it is necessary to get rid of any local irritant that may exist; thus dead bone should be removed, or extravasated urine let out of the areolar tissue. After this has been done, the preventive treatment must consist in the active employment of local antiphlogistic means, such as leeches and cold evaporating lotions: any slight tenderness that continues after the inflammation has subsided must be removed, and the swelling from exudation-matter, which is especially the precursor of chronic abscess, must be got rid of by the continuous application of some discutient lotion. One composed of iodide of potassium ℈j, spirits of wine ℥j, water ℥vij, is extremely useful; in some cases absorption may advantageously be promoted by mercurial ointments or plasters. When once pus has formed, it is a question whether it can be absorbed again; in general, it certainly cannot, more especially if once a distinct cyst have formed around it, but in some cases it may undergo absorption; thus, in hypopyon, we occasionally observe that the pus deposited in the anterior chamber of the eye is removed; and I think it probable that the same may happen when it is infiltrated into the tissues of a part, without a very distinct wall surrounding it. The more fluid parts of chronic abscesses occasionally become absorbed, leaving a cheesy residue, which may degenerate into cretaceous matter.

When, notwithstanding the employment of antiphlogistic means, it is evident that pus is about to form, the treatment should be completely changed, and, by the aid of warmth and poultices, an endeavor should be made to *hasten suppuration*. When this is fully established, the abscess having become "ripe," steps must be taken for the *evacuation of the matter*. The treatment of acute and of chronic abscesses differs essentially in this respect.

[In some cases the formation of pus may be *prevented* by the use of *poultices*. These are especially useful in the treatment of the inflamed breasts of nursing women, and of deep-seated inflammations of the palm.—A.]

In the *acute abscess*, the matter should be let out as soon as it is fully formed, especially in those varieties of the disease connected with a morbid state of the system, as in the metastatic and puerperal forms. When this is done, the constitution at once experiences great relief, the fever and general irritation subsiding materially; the free incision not only letting out the pus and lymph, but removing tension, and, by encouraging local bleeding, lessening the inflammatory action. The rule of opening an acute abscess early is especially imperative when the pus is formed in the sheaths of the tendons and under fibrous expansions, as in the palm of the hand; also when it is situated deeply in the areolar planes of a limb, under the larger muscles, where it has a tendency to diffuse itself extensively. In those cases, likewise, in which pus is lodged in close proximity to a joint or under the periosteum, it must be let out early; so also, when it presses upon mucous canals or important organs, as on the urethra or trachea, or when it is dependent on the infiltration of an irritant fluid into a part, as in urinary extravasation, it must be evacuated without delay. The pus should always be let out early, before the skin covering it is thinned, when the abscess is situated in the neck or in any other part where it is desirable that there should be as little scarring as possible.

In *chronic abscess*, the rule of surgery is not so explicit. Here the collection is often large, coming on without any very evident symptoms and giving rise to no material inconvenience; but, if it be opened, putrefaction of the pus, consequent upon the entry of air into the extensive cyst, will give rise to the most serious constitutional disturbance, setting up irritative fever that may rapidly prove fatal in a debilitated frame; and, should the patient escape this danger, the drain of an abundant suppuration may speedily waste him. Hence, it not uncommonly happens that a patient may carry a chronic abscess unopened, without any very serious disturbance, for many months or even years; but when it is once opened, he dies in a few days. If, however, the chronic abscess be so small that no danger is to be apprehended from the inflammation of its cyst, or if it be situated in parts where it may give rise to dangerous pressure, the matter should be let out without delay.

There are three modes by which abscesses may be opened, each of which possesses advantages in particular cases: These are *incision*, *tapping* with a trocar, and making an aperture into the cyst with *caustic*.

Incision is the only plan that should be practised in *acute abscesses*. For this purpose a lancet, an abscess-bistoury (Fig. 175), or a sickle-shaped knife, may be

Fig. 175.

Abscess-bistoury.

used. The incision should be made either at the point where fluctuation is most distinct, or at the most dependent part of the tumor, so as to prevent after-bagging of the matter. It should be made by holding the bistoury or lancet short, and introducing it perpendicularly into the softened part. If the depth to be reached is considerable, a bistoury should be used, the blade of which should be half turned round after its introduction, when the pus wells up by its side, the point being felt to move freely in the cavity of the abscess. The incision must then be continued for a moderate extent in the direction of the natural folds of the skin of the part, or in the course of the vessels. The pus should be let out freely, so as to allow the walls of the abscess to collapse, but it should not be forced out by squeezing the sac.

It may happen, after the escape of the pus, that the cavity of the abscess fills with blood by the rupture of some small vessel situated in its wall; this, however, is of little moment, the hemorrhage speedily ceasing on the application of pressure, of a bandage, or of cold.

Provided the incision have only to be carried through the integumental structures and fascia, in order to afford an outlet for the pus, there can be but little danger of hemorrhage from the accidental wound of any bloodvessel of importance; and should bleeding occur, it will probably be of a venous character, and may be arrested by pressure and position. But when the abscess is more deeply seated than this, lying under the superficial muscles, where it will then be necessary to penetrate, more serious consequences may ensue, and the incautious use of the knife may lead to the most perilous results. This is more particularly apt to happen in deeply-seated periosteal abscesses of the thigh; and I have more than once known such profuse arterial hemorrhage follow incisions made for the purpose of evacuating pus deeply lodged in the limb in these cases, as to necessitate the ligature of the femoral artery. In order to avoid this danger, Hilton has advised that abscesses so situated should be opened in the following way. An incision is made through the integuments and fascia so as to expose the muscle under which the pus lies; a director is then pushed through the substance of the muscle into the cavity of the abscess, and along the groove of this as a guide a slender pair of dissecting forceps is pushed: when it reaches the abscess the blades are opened up, the muscular fibres separated, and free exit given to the pus.

After the opening has been made, a poultice or water-dressing must be applied. The cavity left eventually fills up either by the coalescence of its sides, or by granulating from below; if it fill again with pus, a fresh incision, termed a "counter-opening," must be made in the most dependent part. Nothing is more dangerous than pent-up matter in imperfectly opened abscesses. It speedily decomposes and becomes offensive, gives rise to local irritation and inflammation, and predisposes to the occurrence of erysipelas and pyæmia. In order to prevent these evil consequences, recourse must be had to free openings in dependent situations, and the use of the drainage-tube.

In the treatment of *chronic and cold abscess*, any one of these three plans may be employed for opening the sac. If it be small, an incision should be made into it at once. If the collection be considerable, we must wait until an opening has been rendered necessary by the tendency to implication of the skin, or by injurious pressure being exercised on important parts; the pus should then be let out by the valvular aperture recommended by Abernethy, the object being to limit the entry of air into the interior of the abscess, so as to lessen the chance of putrefaction of any pus that is left, and of consecutive inflammation of the cyst. The valvular opening is made by drawing the skin covering the abscess well to one side, then passing the bistoury directly into the sac, and allowing as much of the pus to escape as will flow out by the collapse of the walls of the abscess; before the matter has quite ceased to flow, and consequently before any air can have entered the sac, the skin should be allowed to recover its natural position, so that the aperture in it and in the cyst may no longer directly communicate. A piece of plaster, or of lint soaked in collodion, should be placed upon the external wound, which will probably heal under this covering in the course of a short time. When the cyst of the abscess has again filled somewhat, this process may be repeated; so that, less and less pus being allowed to accumulate in it before each succeeding evacuation, it may gradually contract and close.

Instead of making the valvular opening in this way, a chronic abscess may sometimes be advantageously opened by *tapping with a trocar and canula* of moderate size, the instrument being introduced obliquely between the skin and the abscess, and then made to dip down into the sac. After the withdrawal of the canula, the aperture may be closed as in the former case. There is, however, one disadvantage in this plan of opening abscesses; that, if the discharge be curdy or shreddy, it is very apt to block up the canula, and thus to interfere with the proper evacuation of the matter.

Potassa fusa, though its application be painful, may be advantageously used for opening those chronic abscesses, the skin covering which is much undermined, congested, and discolored. In these cases I commonly employ it with great advantage. It is also useful in the after-treatment, when much solid plastic matter is left, dis-

solving this away by exciting inflammation around it, and thus preventing the formation of sinuses which are otherwise apt to occur.

In some forms of abscesses it will be found that those processes which are necessary for the contraction and closure of the cyst, after its contents have been evacuated, do not readily take place; and it becomes necessary to have recourse to other measures, in order to excite sufficient healthy inflammatory action, to occasion the deposition of that plastic matter by which the cavity is filled. With this view, a *seton* of two or three threads may very usefully be passed across the cyst by means of a nævus needle, or by a long straight needle pushed up through the canula used for tapping (Fig. 176). It should be left in for a few days, by which time healthy

Fig. 176.

Introduction of seton through canula.

inflammation will be set up. In other cases, again, after the cyst has been tapped, the red wash or some tincture of iodine should be injected and left in. These methods of exciting inflammation are especially useful when the cyst is thin, and of a very chronic character. When the walls are very thick and dense, as sometimes happens in abscesses of very old standing situated in the neck, an elliptical piece of the anterior portion of the cyst should be dissected out, and the remainder of the cavity be lightly dressed with lint, and allowed to fill by granulation. This plan of treatment is often very successful; and I have by it cured abscesses in the neck of seven or eight years' standing, which have resisted every other plan employed.

Chassaignac has recommended the employment of *drainage-tubes* in the treatment of *chronic abscesses* of large size. This method, which has been advantageously employed by many surgeons in this country of late years, is practised in the following way: The abscess having been punctured, a small India-rubber tube, one-sixth of an inch in diameter, having several side holes punched in it, is passed into the cavity, one end being allowed to hang out for the pus to drain away. These tubes may very conveniently be introduced by being fixed on to the end of a forked probe (Figs. 177, 178), by which the tube is carried into the abscess and left there on the withdrawal of the probe. Another plan consists in passing the perforated India-rubber tube completely across the abscess, drawing it out through a counter-opening, and tying the two ends together. By this contrivance the pus is carried off by the side of rather than through the tube as quickly as it is secreted, the walls of the abscess collapse, and, as gradual closure takes place, the tube may be withdrawn. In some cases the drainage-tubes have appeared to me to act in another way than by merely removing the purulent secretion, viz., by irritating the wall of the abscess just as a seton would, and thus setting up increased activity, and materially augmenting the discharge. On their withdrawal, however, this stimulation has been found to be beneficial, causing a speedier closure of the suppurating cyst.

Fig. 177.

Forked probe for introducing drainage-tube.

Fig. 178.

Drainage-tube and forked probe.

[Where simple drainage is needed, without stimulation, a silver probe, as recommended by Dr. H. Lenox Hodge, of this city, or a seton of strong wire, may be usefully employed; the pus escapes aside of the metal, and the cavity is as well drained as by a gutta-percha tube. If, on the other hand, the walls of the abscess

be callous and indisposed to heal, a thin tarred rope, or a few threads of oakum may be used as a seton with great advantage. The same plan may be adopted to induce the healing of old sinuses resulting from gunshot wounds. The tarred rope or oakum may even be passed through a carious bone, or one affected with limited necrosis, with the result of stimulating the part to healthy activity.—A.]

The *constitutional treatment* of abscess must be conducted on the general principles laid down in discussing the management of suppurative inflammation (p. 113). It must be borne in mind that, as abscess is always a disease of debility, a tonic and stimulant plan will early be required.

Hemorrhage into the Cavity of an Abscess is not of unfrequent occurrence. It may arise from three sources: 1. Oozing of blood from the vascular wall of the abscess; 2. An ulcerated vein; 3. Ulceration or sloughing of a neighboring artery.

The bleeding which occurs *from the abscess-wall* is the most frequent, and the least important. It sometimes takes place before the abscess is opened, the pus that escapes being then found to be sanious and mixed with small coagula. More commonly it occurs after the opening of the abscess, in consequence probably of its wall having lost the support of the contained pus, when the vessels in the soft plastic and very vascular lining give way, and the cavity speedily fills with blood. In these cases the hemorrhage may always be arrested by laying open freely the cavity of the abscess, turning out the coagula, and applying cold or pressure. It usually ceases of itself as soon as the cavity has been freely opened up.

Hemorrhage from *ulceration extending into a neighboring vein*, is necessarily far more serious. It usually has happened in sloughy abscesses formed on the side of the neck or under the angle of the jaw, as a consequence of scarlatina in strumous and unhealthy individuals, and opening up the internal jugular vein. But it may arise, independently of any specific inflammation, in cachectic patients. In these distressing cases, the only treatment that can be adopted is, to plug the cavity of the abscess with lint soaked in a solution of the perchloride of iron, and supported by bandage or plasters. In this way the fatal event may be for a time perhaps delayed; but it is inevitable ultimately, the blood bursting forth by the sides of the plugs as these become loosened, or as the sloughing action opens up the vein more widely. The fatal effect of the bleeding is greatly aggravated by the depressed state of the system, laboring under the conjoined influences of a large infiltrated and sloughy wound and of a specific poison.

If the hemorrhage arise from the *ulceration of a large artery*, the case necessarily becomes one of extreme urgency. I have known this condition occur in the neck and in the thigh; in the neck from sloughy scarlatinal abscess implicating the carotid; in the thigh, from the extension of ulcerative action from abscess and sinuses to the deep femoral. When this untoward complication of abscess occurs in the neck, the hemorrhage is usually so sudden and so profuse that the surgeon has not had time to tie the carotid before life has been extinguished. In the thigh the case is not so urgent. Warnings by repeated small hemorrhages may have enabled the surgeon to adopt means to restrain the bleeding; and, in the case to which I allude, that of a young man, the femoral was tied successfully. In these cases, it is worse than useless to trust to secondary means for the arrest of the bleeding. When practicable, the artery should be compressed, the cavity freely opened up, and the bleeding vessel sought for and tied. If it cannot be found, the main trunk must be ligatured; and for obvious reasons this is the only course that can be pursued in the neck.

Sinus and Fistula.—After an abscess has been opened, its cavity may not fill up completely, but, contracting into a narrow suppurating track, may form a canal without disposition to close, and from which a small quantity of pus constantly exudes, thus constituting a *sinus* or *fistula*.

The *causes* of this non-closure of the cyst of an abscess may be referred to the following heads: 1. The presence of a foreign body, as of a piece of dead bone at the bottom; 2. The passage of irritating secretions, as of urine, feces, saliva, &c., through the abscess; and 3. The contraction of neighboring muscles; as when the abscess is in the neighborhood of the sphincter ani, and as occasionally happens in abscesses about the limbs.

Structure.—A sinus or fistula consists of a narrow channel, often long and winding, having an external orifice usually somewhat protuberant, being situated under

or among loose florid granulations. The walls of this channel, which are always indurated, are lined by a structure resembling mucous membrane; this, however, it is not, but simply consists of a layer of imperfectly formed granulations, exuding ichorous pus. If the orifice be occluded, this pus will collect within the sinus, and, distending its walls, reconvert it into an abscess. In structure, therefore, a sinus or fistula may be said to be a long, narrow, chronic abscess, with a permanent external aperture.

The *treatment* of a sinus or fistula has reference to its cause in the first instance; for until the foreign body that keeps it open and maintains the discharge has been removed, it will be useless to attempt its closure. After the removal of the obstacle to healing, we may endeavor to procure obliteration of the sinus by one of three methods.

1. *Pressure*, by means of a roller and graduated compress, so as to cause an agglutination of its opposite sides, is useful in those cases in which the sinus is recent, without much surrounding induration, and so situated, as upon the trunk, that pressure can easily be applied.

2. A more healthy inflammation may often usefully be excited in the sinus, by *injecting* it from time to time with red wash or with tincture of iodine, by passing the threads of a *seton* through it, or by stimulating it by the occasional contact of a *red-hot iron*. My colleague, Mr. Marshall, has invented a very ingenious and useful apparatus, by means of which a platinum wire, introduced cold, is heated red-hot by the galvanic current. This *galvanic cautery* has frequently been employed with much success in the University College Hospital in the treatment of fistulæ and sinuses, to which other methods were not very applicable.

3. The last method consists in *laying open the sinus* from end to end, and then dressing the wound so that it may heal from the bottom; in this way neighboring muscles, that have kept it open by their contractions, may also be set at rest. The division of the sinus should be made with a probe-pointed bistoury, introduced through the external opening either by the aid of a director or without such assistance. The operation should be done effectually, the sinus being usually followed as far as is prudent, and laid completely open.

CHAPTER XXIX.

ULCERS.

Various forms of *ulcer*, affecting the cutaneous surface or mucous membranes, are familiar to the practical surgeon. When occurring in the skin, as the result of non-specific disease, they may be arranged under the following heads: the healthy; the weak; the indolent; the irritable; the inflamed; the phagedænic or sloughing; the varicose; and the hemorrhagic. Besides these varieties, each of which is marked by distinct characteristics, various other forms of ulceration depending on specific causes, as the syphilitic, scrofulous, lupoid, cancerous, &c., are met with; all of which will be treated of under their respective chapters.

The varieties presented by ulcers are by no means dependent on local conditions merely, though these influence them greatly, but are in a great measure owing to constitutional causes. Indeed, the aspect of the ulcer, and the character of its granulations and of its discharge, are excellent indications of the state of health and of the general condition of the patient, as well as of the local disease.

Ulcers may be situated upon any part of the cutaneous surface as the result of violence; most commonly when arising from some specific affection they occur in particular situations, as on the penis, lips, tongue, &c.; but when they occur from disease of non-specific character they are usually seated on the leg.

It is the lower half of the leg that is the common seat of these simple ulcers, which there occur in every possible variety. They are most common at or after the middle period of life, and are more frequently met with in the poorer classes. They are especially predisposed to by all those circumstances that favor weakness of circula-

tion, and consequently low vitality of the part—as exposure to cold and wet, want of food, &c. The skin of the lower part of the leg is prone to these ulcerations, in consequence of its natural thinness, the feebleness of its circulation, more especially in advanced life, and its liability to venous congestions from position. Ulcers that once form here are slow in healing and very liable to recurrence, for the same reasons that lead to their formation, coupled with the absence of a proper subcutaneous areolo-adipose bed, and the consequent tendency of adhesion of the under surface of the ulcer to the aponeurosis or periosteum.

Healthy or Purulent Ulcer.—This may be considered the type of the disease. It presents a circular or oval surface, slightly depressed, thickly studded with small granulations exuding laudable pus, and having a natural tendency to contract and heal. It is the object of all our treatment to bring the other forms of ulcer into this condition.

Treatment.—In the management of the healthy ulcer, the treatment should be as simple as possible; water-dressing and the pressure of a bandage usually enabling it readily to cicatrize.

Weak Ulcer not uncommonly occurs from emollient applications having been continued for too long a time in the last variety of the disease; the granulations then becoming high and flabby, with a semi-transparent appearance about them, and sometimes rising in large, exuberant, gelatinous, reddish-looking masses above the surface of the sore. These high granulations have a feeble vitality, and readily slough.

The *treatment* of this form of ulcer consists in keeping the part elevated and carefully bandaged, and applying an astringent dressing to the sore, such as a weak solution of the sulphate of zinc or copper, or the "red wash," according to the following formula: sulphate of zinc, gr. xvj; compound tincture of lavender and spirits of rosemary, of each ʒij; water, ʒviij. This will be found a most useful application; and the granulations may be touched from time to time with nitrate of silver.

Indolent Ulcer.—This is always very chronic. It is situated upon the outer side of the lower extremity, between the ankle and calf, and most frequently occurs in men about the middle period in life. It is deep and excavated, with a flat surface, covered by irregular and badly formed granulations, exuding a thin and sanious pus, having hard, elevated, and callous edges, and presenting generally an irregular and rugged look. The surrounding integument is congested, and matted to the subjacent parts; there is usually very little subcutaneous areolar tissue about it, the skin being firmly fixed to the subjacent fascia; and it would appear as if it were in consequence of this want of a vascular substratum from which to spring, that granulations do not readily arise. There is no pain attending this ulcer, and its surface, which often attains a very large size, may usually be touched without the patient feeling it.

Treatment.—The principle of the treatment here is twofold; to depress the edge, and to elevate the base of the sore. This is effected by pressure and stimulation conjoined. The treatment should be commenced by rubbing the surface of the ulcer and the surrounding congested integument with nitrate of silver; a linseed-meal poultice should then be applied for twenty-four hours, after which the sore should be properly strapped on the plan recommended by Baynton. The best plaster for this purpose is the *emplastrum saponis*, to which some of the *emplastrum resinæ* is added to make it sufficiently adhesive; this, spread upon calico, should be cut into strips sixteen or eighteen inches in length, and about an inch and a half in width; the centre of the strip should then be laid smoothly on the side of the limb opposite to the sore, and the ends, being brought forward, are to be crossed obliquely over it. Strip after strip must be applied in this way, until the limb is covered for a distance of a couple of inches above and below the ulcer. If the sore be near the ankle, this joint should be included in the strapping. Each strip of plaster should be applied with an equal degree of pressure, which may often be considerable, and it should cover at least one-third of the preceding strap; the limb must then be carefully bandaged from the toes to the knee. Under this plan of treatment, the edges will subside, the surface of the sore will become florid, and granulations yielding abundant discharge will speedily spring up. Much of its success will depend upon the close attention that is paid to the case. If the skin be irritable, no resin-plaster should be used, but merely the soap or lead; and the

plasters should be changed at least every forty-eight hours. If the discharge be very abundant, small holes should be cut in the strips to allow it to escape. When by this plan of treatment the edges of the sore have been brought down, and the granulations sufficiently stimulated, an astringent lotion with bandaging may advantageously be substituted for the plasters. In some of these cases, I have found benefit from the internal administration of liquor arsenicalis.

[The edges of the ulcer may be advantageously treated by the radiating incisions recommended by Mr. Gay. In some cases, the whole surface of the ulcer may be blistered, as advised by Prof. Syme, or may even be dissected off with a sharp scalpel. Plastic operations for the cure of old ulcers of the leg, have, in cases where I have used them or seen them used, uniformly failed.—A.]

Irritable Ulcer is mostly met with in women about the middle period of life, especially in those of a nervous and bilious temperament. It is usually of small size, and situated about the ankles, or upon the shin. Its edges are irregular, but not elevated; the surface is grayish, covered with a thin slough, and secreting unhealthy sanious pus. Its principal characteristic is the excessive pain accompanying it, which often, by preventing sleep, disturbs seriously the general health.

In the *treatment* of this ulcer, we must attend to the constitutional as well as to the local condition. The patient should be put upon an alterative course of medicine, with aloëtic purgatives, and some sedative at bedtime to procure rest. The mode of topical medication which I have found to succeed best, is to brush the surface of the sore and the surrounding parts from time to time with a strong solution of nitrate of silver, and then to keep emollient and sedative applications applied to it, such as lead and opium lotions. The occasional application of the nitrate of silver deadens materially the morbid sensibility of the sore, and assists its granulation.

Inflamed Ulcer.—This is characterized by much redness, heat, and swelling of the surrounding parts, with a thick and offensive discharge, often streaked with blood; it may arise from the over-stimulation of one of the other varieties.

The *treatment* must be locally and generally antiphlogistic. The elevated position, the application of leeches around the sore, and of cold evaporating lotions to the surface of the limb, speedily subdue the inflammatory action; and the healing process then takes place with great rapidity.

Sloughing Ulcer.—When not specific, this is an increased degree of the inflamed variety, usually occurring in a feeble or cachectic constitution, and generally accompanied by a good deal of irritative fever. An angry dusky red blush forms about the sore, which becomes hot and painful; the surface assumes a grayish sloughy look, the edges are sharp cut, and the ulcerative action extends rapidly.

Treatment.—This should consist in improving the general health by lessening irritation, and keeping up tone. The administration of opiates, with nourishing but unstimulating diet, should be trusted to at the same time that the local action is subdued by rest and warm opiate lotions. When the inflammatory condition has subsided, tonics should be given internally, and a grain or two of the sulphate of copper or of zinc may be added to the lotion with which the sore is dressed.

The specific varieties of sloughing ulcer will be considered in the chapters on hospital gangrene, &c.

Varicose Ulcer derives its chief characteristic from being complicated with, or dependent upon, a varicose condition of the veins of the leg. In this affection of the venous trunks the skin gradually undergoes degeneration, becoming brawny, of a purplish-brown color, and being traversed in all directions by enlarged and tortuous cutaneous veins. The ulcer forms at one of these congested spots, by the breaking down of the already disorganized and softened tissue, forming a small irregular chasm of an unhealthy appearance, and varying much in character, being sometimes inflamed, at others irritable or sloughy, and then becoming indolent. One of the most serious effects of this ulcer is that, by penetrating into one of the dilated veins, it occasionally gives rise to very abundant hemorrhage; the patient, in the course of a few seconds, losing a pint or two of blood. This hemorrhage may be readily arrested by laying the patient on his back, elevating the limb, and compressing the bleeding point with a pledget of lint and a roller.

The *treatment* of a varicose ulcer must have special reference to the condition of the veins that occasions it; no local applications having much effect unless the pressure of the column of blood in the dilated vessels be taken off the part. This may be done by means of a well-applied bandage, made of elastic material, or

a laced or elastic stocking applied to the leg, so as to keep up uniform pressure upon the distended vessels. In some cases, the length of the column of blood may be broken by the application of a vulcanized India-rubber band below the knee. In many cases, the cicatrization of the ulcer cannot be brought about in this way; or, if it heal, it will constantly break open again: or hemorrhage may have occurred from a ruptured vein upon its surface: means, which will be described in a future chapter, must then be taken for the permanent occlusion of the varicose vessels by ligature.

As this procedure, however, is attended by some danger from the occasional induction of phlebitis or erysipelas, it should not be had recourse to unless the existence of one or other of the conditions just mentioned urgently calls for it.

Hemorrhagic Ulcer.—This is a dark purplish-looking sore, occurring in women suffering from amenorrhœa, and having a special tendency, whence its name, to ooze blood about the menstrual periods. It usually partakes of the character of the irritable ulcer.

Treatment.—The hemorrhagic ulcer requires to be treated by constitutional means, having for their object the improvement of the patient's general health; with this view, the preparations of iron and of aloes are especially useful.

Ulcers on Mucous Membranes.—Various forms of ulcer occur upon the mucous membrane of the throat, rectum and genital organs. As these, however, are commonly of a specific character, they will be hereafter described.

When ulcers of the mucous membrane are not of a specific character, they present the general appearances characteristic of the cutaneous healthy, inflamed, or weak varieties, and require the topical applications which have been described as suited to these conditions; though generally they will bear and require the free employment of caustics, especially of the nitrate of silver.

CHAPTER XXX.

MORTIFICATION, OR GANGRENE.

The local death of a part of the body, in surgical language, is termed *mortification* or *gangrene.* When the morbid action is confined to the osseous structures or to the cartilages, it is termed *necrosis;* when limited to the soft tissues of a limb, *sphacelus;* and when accompanied by ulceration, it is called *slough.* Many other varieties of gangrene are recognized by surgeons. Like all other diseases, it may be *acute* or *chronic* in its duration; as the parts affected are moist and swollen, or dry and shrivelled, it may be divided into the *moist* and the *dry* or *mummified* gangrene; so again, according to its cause, it is spoken of as *idiopathic* or *traumatic;* and very frequently, and most correctly perhaps, it is arranged under the denominations of *constitutional* and *local*, without reference to the comparatively accidental circumstances of its dryness or moisture. Besides these, various *specific* forms of the disease are met with, which will require special consideration.

Local Signs.—Whatever form the gangrene may assume, there are certain local phenomena that are common to all the varieties of it. The part becomes colder than natural; not only is it colder than the corresponding part on the opposite side of the body, but the temperature falls below that of surrounding media, owing to the evaporation that goes on from the surface. The sensibility of the part is lost. It may be touched, pricked, or cut without feeling. In some cases the sensibility is greatly increased just before gangrene sets in, there being intense agonizing pain of a burning or neuralgic character experienced in it, which soon gives way to complete insensibility. All motion of the part itself ceases. It may be moved by muscles from a distance, as a mortified toe might be moved by the unaffected flexors or extensors, but it has no power of motion independently of what is communicated from a distance. The skin of the mortified part becomes discolored, usually grayish or greenish, the cuticle separates, and when pressed upon obliquely slides away under the finger, leaving the moist and slippery cutis exposed. The color gradually

darkens to a dull purplish greenish black, mottled in patches with reddish-brown spots, and after a time there is an odor of putrescence evolved, very commonly with an emphysematous crackling from effusion of gas into the tissues of the part. The color of the part affected is usually of a dark purplish or greenish black, more or less mottled with red. This, which is unlike anything else in the system, shows that putrefactive changes have taken place in the solids and fluids of the diseased tissues, and is usually connected with the *moist* and swollen form of the disease. In the *dry* variety of gangrene the color is often at first of a pale tallowy-white, with a mottled appearance upon the surface. The skin soon shrivels, becomes dry, horny, and semi-transparent, and eventually assumes a brown wrinkled appearance; in other cases the gangrened part is brown, dry, and shrivelled from the very first. These differences in the color of the mortified part indicate corresponding differences in the cause of the affection. In general terms, it may be stated that the dark varieties of gangrene are the result of destructive changes taking place in the very part itself, or are of constitutional origin; whilst the pale form of the affection occurs as a consequence of some obstruction in the supply of blood to the part, and is a local disease, influencing the constitution secondarily. But it must be borne in mind that gangrene may have occurred, that is to say, that the part may have lost its vitality, without having become dark, fetid, or emphysematous. These signs, though sometimes contemporaneous with loss of vitality, are more frequently consecutive to it, and indicate more than the simple death of the part; they are proofs of putrescence having set in, as well as of death having occurred.

The processes adopted by nature for the arrest of gangrene by the formation of a *line of demarcation*, and for the detachment of the parts that have lost their vitality by the extension of ulceration along the *line of separation*, have already been fully described (pp. 119–120).

Constitutional Symptoms.—These vary greatly. When the disease is strictly local, affecting a part of but limited extent, and perhaps of no great importance to the economy, they are not very strongly marked. If, however, the gangrene, although limited, implicate organs of importance to the system, as a knuckle of intestine, for example, marked symptoms declare themselves. Whatever the precursory condition may be, the full invasion of the gangrene, if it be of rapid occurrence, is always accompanied by constitutional disturbance of an asthenic type, attended by great depression of the powers of the system, with a dull and anxious countenance, and a feeble, quick, and easily compressible pulse; the tongue is brown, and soon becomes loaded with sordes. When the gangrene is internal, a sudden cessation of pain, with hiccup, vomiting, and tympanitic distension of the abdomen, may be superadded to the symptoms, and indicate the mischief that has occurred. Death usually supervenes with low delirium, twitchings, and coma. When the invasion of the gangrene is more gradual, as in some of the constitutional forms affecting the lower extremities, the symptoms are usually those of irritative fever, eventually subsiding into the asthenic form.

Diagnosis.—The diagnosis is easily effected when gangrene has fully developed itself; but in the early stages, before it is positively declared, it is not always an easy matter to determine its existence. The ecchymosis and discoloration of a bruise, the collapse and lividity that result from cold, or the dark purple hue occasioned by long continued congestion, may readily be confounded with impending gangrene. In these cases of doubt, the surgeon should not be in too great a hurry to pronounce an unfavorable opinion, and still less to act upon it; for it not uncommonly happens that parts of the body which have to all appearance lost their vitality, may by proper treatment regain it.

Prognosis.—So far as the part itself is concerned, the prognosis is always bad; though occasionally, when gangrene has not been fully established, partial recovery may unexpectedly take place. So far as the life of the patient is at stake, much will depend on the cause of the affection, and on the age and strength of the individual; at advanced periods of life, and in a feeble state of system, the result is always unfavorable. Also whilst the gangrene is spreading, the prognosis is bad, as it is impossible to say where the morbid action may stop; but when the line of demarcation has formed, indicating the possession of a certain vigor of constitution, the principal danger is over, and the result will depend on the power of the patient, and the support that can be given during the processes of separation and of repair.

Causes.—The causes of gangrene are very various. They may be arranged under four principal heads.

1. The *intensity or specific nature of the inflammation* of a part may give rise to its death by the stagnation of the blood within its vessels, or by inducing such changes in it as are incompatible with life.

2. The *arrest of the circulation* through a part is a common cause of gangrene. It may be occasioned in one of three ways: by strangulation of the part generally; by obstruction of the flow of blood through the main arteries leading to it; or by the return of blood through the principal veins coming from it being interfered with.

3. *Traumatic causes* of various kinds give rise to different forms of gangrene, most of which we have already considered. Thus, gangrene of a part may be occasioned by severe contusion, compression, or laceration (page 136); or by the infiltration of an irritating fluid; and, lastly, the exposure of a part to intense heat or cold will destroy the vitality of the tissues.

4. *Specific poisons* of various kinds occasion special diseases of which gangrene is the principal characteristic. Thus, hospital gangrene, malignant pustule, noma, carbuncle, and ergotism, are instances of specific affections accompanied by gangrenous action.

Amongst the causes, some are *constitutional*, others *local*, in their action. Those forms of gangrene are said to be *constitutional* which arise from intense or specific inflammation of the part; from obstruction of the circulation in consequence of a diseased state of the heart and vessels; or from the action of various specific poisons. On the other hand, those varieties of gangrene are *local* which arise from injuries of all kinds, whether applied to the part itself, or to the main artery leading to it, by its ligature or wound.

Some of the varieties of gangrene that have just been indicated, such as those arising from the intensity of the inflammation, and from various traumatic causes, have already been discussed (pp. 118, 136); whilst those that arise from obstructed circulation, or that take the form of specific diseases, are left for our consideration here.

Gangrene from Arrest of Circulation.—Arrest of circulation may act in three ways in inducing gangrene: 1, by the arrest of all the blood, arterial, venous, and capillary, in the part, as in *strangulation* by a tight ligature; 2, by *obstruction of the arteries*, and consequent deprivation of blood; and 3, by *venous obstruction*, and consequent over-accumulation of blood.

1. *Strangulation.*—A part is often purposely strangled by a surgeon in operative procedures; or its circulation may in this way be arrested as the result of certain diseased conditions. In either case, the strangulation acts by stopping more or less completely the whole circulation of the part. If it be sufficiently severe, it may kill the tissues outright: for instance, when a nævus or a pile is tied, all flow of blood to or from the part is suddenly arrested, and its vitality is destroyed, the tissues that have been strangled shrivelling and separating by ulceration along the line of ligature. When the strangulation is not so severe as this, great congestion in the part ensues, consequent on the interference with the return of the venous blood; the part strangled becomes dark and congested, phlyctenæ or vesicles arise on its surface, and effusion takes place into its tissue; inflammation becomes at last superadded to the effects of the strangulation, and still more embarrasses the circulation of the part; and thus sloughing arises, from the conjoined action of the strangulation and the inflammation. All this we see occurring in the constricted gut of a strangulated hernia.

2. *Arterial Obstruction.*—When a part of the body is deprived of its proper supply of blood, mortification may ensue. This we see occasionally happen when the circulation through the main artery of a limb is arrested by its ligature or wound. Most commonly, when the principal trunk of an artery is obstructed, the collateral circulation is sufficient to maintain the vitality of the part; but, should this be interfered with in any way, gangrene ensues from the simple deprivation of that blood which is necessary to the maintenance of its life. Indeed, the sudden loss of a large quantity of blood from the system generally may occasion the death of some of the extreme parts of the body, in which the circulation is naturally most languid. Thus, Sir B. Brodie relates the case of a drunken man, who, being bled to an inordinate extent, was seized with gangrene of both feet.

The want of a due supply of arterial blood to the limb may be occasioned by two primary sets of causes: *a*, from *injury or operation*, as wound or ligature of the main trunk: *b*, from *disease*, as by *obstructive arteritis;* by *embolism;* by *calcification, and consequent occlusion of the vessel.* Gangrene from arterial obstruction varies materially in its symptoms, prognosis, and treatment, according as it arises from one or other of these causes.

a. When a limb becomes gangrenous in consequence of the *ligature or wound of its main artery*, without any other injury to the vascular system, it will be found to become cold, to feel heavy, and to lose its sensibility; at the same time it assumes a dull tallowy-white color, mottled with grayish or brownish streaks. This state of things is chiefly met with in the lower extremity; the integuments of the foot die, becoming semi-transparent and horny-looking where they are stretched over the tendons of the instep, and the part presents a shrivelled appearance. In the course of a short time the pallid color will be lost, the part becoming brown or blackish. This form of gangrene may invade the whole of the lower limb, but most commonly is limited to the foot, stopping either just above the ankle, or if not, then immediately below the knee, as Guthrie has observed; the arrest taking place in one or other of these two spots, on account of the greater freedom of the collateral circulation here than in other parts of the limb. If any of the large venous trunks become obstructed or otherwise implicated, so that the return of blood through them is interfered with at the same time that the supply by the arteries is arrested, the limb generally assumes a greenish-blue color, and rapidly runs into putrefaction. In some of these cases it happens that sloughs of the integument and subcutaneous areolar tissue form, although the limb generally preserves its vitality. The treatment of these forms of gangrene, which are strictly local, is described in the chapter on the Arrest of Arterial Hemorrhage (p. 173).

b. Gangrene may occur from the circulation being arrested by *disease* taking place in the coats of the arteries, or in the contained blood. This is the variety of the affection that is commonly called *spontaneous.* It may be the result either of obstructive arteritis, of embolism, or of the plugging up of an artery that has undergone calcification or senile degeneration.

Spontaneous gangrene from *acute obstructive arteritis*, without previous disease of the vessel, may occur at all ages; in young people as well as in old. In it there are the usual signs of arteritis, such as tenderness along the course of the vessel, cessation of pulsation in its terminal branches, intense superficial pain in the limb, followed by the rapid supervention of dark dry gangrene in the whole of the extremity up to the point at which the vessel is inflamed. In some cases the gangrene partakes of the characters of the humid form, owing to the implication of the contiguous veins. It is, I believe, most frequently met with in the upper extremities; at least, most of the instances that I have seen of it have been situated there. I have observed it most commonly in women, occurring sometimes at an early period of life, even at the eighteenth year. Its causes are very obscure; in some cases the disease appears to be of rheumatic origin, in others it is connected with a cachectic and broken state of constitution. It frequently proves fatal by the supervention of typhoid symptoms, before any attempt can be made by nature to separate the mortified part. After death, the inflamed vessel will be found firmly plugged up by a dense coagulum, which completely arrests the circulation through it. It is by the formation of these coagula plugs or emboli that arteritis occasions gangrene. In these cases the terminal branches of the arteries, and the capillary vessels, become plugged up by a mass of finely granular fibrinous matter, which is washed down and into the lower part of the vessel from the inflamed patch on the inner surface of the artery at a higher point. In peculiar conditions of the blood, at present of an uncertain character, this plugging is more specially apt to occur.

Fig. 179.

Obstruction of femoral artery at its bifurcation by a fibrinous plug.

Embolism is a cause of spontaneous gangrene. In some cases the gangrene appears to be occasioned by a plug of plastic matter which has been detached from a distant part of the circulatory apparatus, from the interior of the left ventricle for instance, and, being carried by the circulation into the arterial system, stops at some point of bifurcation or of narrowing of a vessel. In such cases the gangrene may develop itself suddenly. The accompanying drawing (Fig. 179)

represents the bifurcation of the common femoral artery occupied by a fibrinous plug, taken from a man aged 32, who died of gangrene of the left leg. In this case the patient, after recovering from rheumatic endocarditis, whilst straining at stool, suddenly felt his left leg tingle painfully, then become numb and cold. The circulation in it ceased, and gangrene speedily supervened, which extended as high as the knee. Death followed amputation of the limb. Here there can be little doubt that the sudden supervention of gangrene was the result of obstruction to the arterial circulation of the lower extremity, consequent on the detachment of a fibrinous endocardial plug, and its arrest at the bifurcation of the femoral artery.

Spontaneous gangrene is termed *senile* when it occurs in old people in consequence of the *coats of the arteries becoming rigid and calcified* (Fig. 180), and unable to maintain the proper circulation of blood through the limb. The want of a due supply of arterial blood in these cases is not only owing to the diseased state of the arteries, but is in a great measure due to the feeble propulsive power of the heart, and the consequent naturally weakened circulation through the lower limbs especially. When the circulation is so enfeebled as to cause the nutrition of the limb to be lowered, coldness, cramps, and in some cases cutaneous ulcerations will ensue. When the circulation becomes arrested from the conjoined influences of diminished cardiac propulsive power and arterial obstruction, gangrene inevitably results. It is met with in the lower extremities of people past the middle period of life, and the tendency to it increases as age advances. The premonitory symptoms are as follow: A sensation of weight in the limb, with coldness, itching, and tingling in the feet, and with cramps in the calves, is complained of, and the circulation of the part is habitually defective, the pulsation of the tibials being scarcely perceptible. This condition commonly exists for a considerable length of time before gangrene actually comes on, and should always be looked upon with anxiety in old people. In many instances the disease sets in without any exciting cause; but in other cases the mortification is immediately developed, as the result of some slight inflammation accidentally induced, as from the excoriation produced by a tight boot, or from a trivial wound in cutting a corn or toe nail; the inflammation occasioned by this slight injury being sufficient to disturb the balance of the circulation in the already weakened part to so great an extent, that gangrene ensues. In other instances, again, the disease is ushered in by more acute symptoms. The whole foot becomes swollen, œdematous, and red; inflammation, apparently of a gouty character, being set up in it. In whatever way it begins, the gangrene may at first only affect one toe, or it may from the commencement involve several. It most generally in the first instance makes its appearance in the form of a cold purple or blackish-red spot on the side of one of the toes, usually the inner side of the great toe; this spot may be surrounded by an inflamed areola, and accompanied by much smarting and burning pain of a paroxysmal character; it spreads by gradually involving the inflamed areola, which continues to extend in proportion as the gangrene progresses. The pain, which is often of the most intense character, subsides when the gangrene becomes complete. In other cases the toes and foot simply shrivel, without any sign of local inflammation, and with but little constitutional disturbance. In one or other of these ways the affection gradually creeps up the limb, invading perhaps one toe after the other, involving the instep, the heel, or the sole of the foot; and unless it terminates by the formation of the line of demarcation, or death put an end to the patient's sufferings, it may extend up the ankle or leg. The part that is destroyed is always black, dry, and shrivelled, resembling closely in appearance a dried mummy; hence the change is often termed *mummification* (Fig. 181); the toes often look like the shrivelled skins of over-ripe or sucked-out black grapes. There is usually considerable constitutional disturbance, sometimes pyrexial at first, but secondarily sinking into an irritative or asthenic form; and the disease is often fatal in from a month to six weeks. But this is very uncertain. I have known the disease to continue with very little constitutional

Fig. 180.

Femoral and tibial arteries obstructed in senile gangrene.

Fig. 181.

Senile gangrene of foot: line of separation.

disturbance for more than twelve months, slowly creeping on during that time. In other instances, again, the gangrene being limited to a small extent, as to the toes only, the patient may recover with the loss of the fore part of the foot.

The pathology of the arterial system, in reference to these forms of gangrene, will be more fully discussed in a subsequent chapter.

3. *Venous Obstruction.*—Gangrene may arise from obstruction to the return of blood through the veins of a part, the circulation being arrested by the overloading of the capillaries with venous blood. Gangrene is especially apt to take place if the arterial supply be diminished at the same time that the return of venous blood is interfered with; as when an artery and vein are compressed, or when the femoral vein is wounded accidentally at the time when the artery is ligatured. Gangrene from this cause is always of the moist kind, attended by great swelling from œdema, with discoloration and rapid putrefaction of the part.

This gangrene from venous obstruction is also especially apt to occur in those cases in which the heart's action is weakened, so that the force of the impulse in the arterial system is so lowered as to be unable to push the blood through the loaded veins. Those cases of gangrene of the extremities that are met with from pure debility, as after fevers, often appear to originate in this way.

The various forms of *traumatic gangrene*, whether arising from the severity of the injury, from the inflammation following it, from the depraved condition of the blood, from the irritation of extravasated fluids, or from the effects of burns or frostbite, have already been considered when treating of these respective injuries; and the more *specific* forms of the affection we shall shortly describe.

Treatment.—As gangrene proceeds from a great variety of causes, it must be very evident that no one plan of treatment can be universally applicable; and it becomes necessary to modify our therapeutic means, not only according to the cause of the disease, but also with special reference to the constitution of the patient, and with regard to the stage in which we meet the gangrene; and, indeed, it often requires great tact and experience to accommodate the treatment in this way to the varying phases of the case. I have already considered the treatment of the inflammatory (p. 120) and the traumatic and local (pp. 138, 196) forms of gangrene, and shall, therefore, consider merely in this place the general principles that guide us in the management of those varieties that have been considered as the result of constitutional causes—the *spontaneous* forms; and in these cases the constitutional management of the patient is of greater moment than the local treatment of the disease.

In the *constitutional treatment* of spontaneous gangrene, there are three principal indications: 1. To *remove the cause* if possible, and thus to arrest the gangrene. 2. To *support the powers of the system during the process of the separation of the sloughs and dead tissues;* and 3. To *lessen the irritability of the nervous system.*

1. In the *removal of the constitutional cause*, we must look wholly to the condition of the patient's system. If this be in an inflammatory or febrile state, we must have recourse to the modified antiphlogistic plan described at p. 120. But the opposite condition—an enfeebled state of the circulation of the part or the system generally—may equally occasion or complicate the gangrene; and there may be every possible combination between this and the active inflammatory condition. In these circumstances, it will be necessary to conjoin an antiphlogistic plan of treatment with remedies of a tonic, or even stimulating character. It is this plan of treatment that is commonly found to succeed best in spontaneous gangrene; here moderate antiphlogistics are perhaps required in the earlier stages, with a light nutritious diet and mild tonics as the disease advances; and in the latter periods, when the constitutional symptoms assume an asthenic character, stimulants should be given. The best stimulants in these cases are wine or porter, according to the patient's habits of life; and these should be given in combination with nourishment, so as not merely to raise the pulse, but to produce a more permanent tonic influence

on the system generally. If much depression occur, the medicinal stimulants, especially ether, ammonia, and camphor, are of material service. The only tonics that are of much value here, are the preparations of bark and some of the vegetable bitters, as gentian and cascarilla; and though the specific virtues that were formerly attributed to them can no longer be accorded, yet, when they do not irritate the stomach, they are of unquestionable service in combating the asthenic symptoms and improving the digestive powers. In these cases I look upon bark or gentian, in combination with chlorate of potass and ammonia, as of undoubted value.

2. After the proper employment of means calculated to remove the constitutional cause of the gangrene, the *system must be supported against the debilitating effects that accompany the process of ulceration and of suppuration* necessary for the separation of the mortified parts. During this period, there is less irritation and more debility, and stronger tonics and stimulants can be borne; but we should be careful not to overstimulate the patient. On this point it is extremely difficult to lay down any rule; every possible variety as to the quantity and quality of food and stimulus being required by different individuals. The safest guides are the state of the pulse and tongue; if they improve, the means employed agree. At the same time hygienic measures should be carefully attended to; cleanliness and free ventilation, with the abundant use of the chlorides, are of the first moment, so that the patient may not be poisoned by his own exhalations.

3. The third indication, that of *lessening the irritability of the system* that always supervenes, and which is partly owing to the severity of the pain, and partly to the shaken and depressed state of the nervous system, is best carried out by the administration of opium; and although this drug may not act as a specific, as Pott supposed, yet in many cases, but especially in the gangrene of the toes and feet of old people, it is undoubtedly a remedy of the greatest value. A grain of solid opium may be administered advantageously every sixth, eighth, or twelfth hour, according to the effect which it is found to produce; care being taken that the bowels do not become confined. The hiccup, which is often distressing in these cases, is best remedied by the administration of chloric ether and camphor.

The *local treatment* of the gangrenous part should be conducted on the principles described at p. 121; leaving the separation of the sloughs as much as possible to nature; diminishing the fetor which occurs, by the use of the chlorides of carbolic acid; preventing the absorption of morbid matters at the line of separation; dressing this with wet lint or calamine cerate; and, lastly, endeavoring to heal the ulcer that results on the detachment of the sloughs.

The Treatment of Senile Gangrene, presenting, as it does, some peculiarities, requires a few words to be specially devoted to it.

Constitutional Treatment.—By some surgeons this disease has been treated on a strictly antiphlogistic plan, on the supposition that the obstruction of the arteries is caused by the inflammation of their coats. This, however true it may be in some of the forms of "spontaneous gangrene" arising from acute obstructive arteritis in young subjects, is certainly an erroneous doctrine in the great majority of cases of dry gangrene occurring as the result of senile changes in the lower extremities of aged persons; and, though inflammation may occasionally affect the calcified coats of an artery, or the parts supplied by such a diseased vessel, it is always a low form of the disease, and does not bear depletion. Sir B. Brodie very justly observes, that in these cases the local precursory inflammation terminates in mortification, because the inflamed part cannot obtain the additional supply of blood that it requires; hence, if blood be abstracted from the system, and the action of the heart weakened, the cause of the disease will only be aggravated. But, though depletory measures are not admissible, we must guard against running into the opposite extreme, and overstimulating patients laboring under this disease. Senile gangrene commonly occurs in individuals belonging to the wealthier classes of society, who have lived high, taken insufficient exercise, and consequently induced an irritated, plethoric, but enfeebled state of system. In many cases the patients are of a gouty habit, and occasionally the inflammation that precedes the development of the gangrene appears to be of this nature. In this condition stimulants and the more powerful tonics are not well borne; they heat the system, accelerate the pulse, and interfere with digestion. As Sir B. Brodie observes, it is of great importance in this disease to attend to the state of the digestive organs, in order that nutrition may go on, and that blood of a proper quality may be made. In

order to accomplish this, a light nourishing diet, partly animal and partly vegetable, should be given, and a moderate quantity of wine, beer, or brandy allowed. The bowels must be relieved from time to time by a rhubarb draught or simple aperient pill. It is better to avoid mercury as an aperient in any form in this disease, as it depresses the system: and hence it should not be used, unless the state of the liver imperatively require it. If the digestion become impaired, a stomachic, as the infusion of cascarilla, or the compound infusion of gentian with a little ammonia, may be administered. The administration of opium in these cases, as originally recommended by Pott, has received the sanction of almost every practical surgeon. Brodie's opinion on this point is peculiarly valuable; he says: "If I am not greatly mistaken, the result of a particular case will very much depend on this—whether opium does or does not agree with the patient." From two to four grains of opium may be administered in divided doses in the course of twenty-four hours; the quantity being increased as the system becomes accustomed to its effects. If, however, it disturb the stomach and occasion headache, notwithstanding the use of aperients, as will often happen when there is febrile disturbance in persons of a full habit of body, it must be discontinued, as it will increase the irritation of the system. The pain in the foot, which is often very severe during the progress of the disease, usually ceases of itself when the mortification is complete, and before this is but little influenced by any sedatives, whether constitutionally or locally applied. With respect to the comparative advantages of the depletory and stimulating plans of treatment in senile gangrene, I think it may fairly be stated that neither method should be employed exclusively; that in those cases in which there is much febrile action going on, in which the tongue is loaded, the pulse quick, and the skin hot, in which the spread of the gangrene is preceded by a red angry blush, with much pain and heat, moderate diet and mild tonics will be most useful; whilst, on the other hand, when it is simply a shrivelling of the toes and feet, without any sign of being preceded by increased local action, or by constitutional disturbance of a febrile type, a decided tonic or stimulating plan will succeed best.

The *local means* to be employed in senile gangrene are simple. It is of great importance to keep up the temperature of the limb, and to equalize its circulation as much as possible; this is best done by the application of cotton-wadding or of carded wool in thick layers around the foot and leg, so as to envelop the limb completely in this material, over which a large worsted stocking may be drawn, or a silk handkerchief stitched. This dressing need not be removed more than once or twice a week, unless there be much discharge from the line of separation, when it must be changed more frequently; the gangrened part itself should be covered with a piece of lint soaked in chlorinated lotions. When the soft parts have been separated, and the bones of the foot exposed, these should be cut across by means of cutting-pliers or a small saw, and the sore that results dressed in the ordinary way with some astringent lotion or slightly stimulating ointment. The balsam of Peru, either pure or diluted, with an equal part of yelk of egg, is a very excellent application in these cases. In the event of the recovery of the patient, he must be careful to avoid exposure to cold, and to keep the legs warmly clad at all seasons of the year.

Amputation in Gangrene.—The question of amputation in cases of gangrene of the limbs is of great importance to the practical surgeon, and is one on certain points of which the opinions of the best practitioners are still at variance. At first sight it appears rational to cut off a limb that is dead, disorganized, and offensive; and with propriety this may be done when the gangrene is, strictly speaking, a local condition, as, for instance, the result of a severe injury: any affection of the constitution in such a case as this being secondary to the local mischief, and dependent on the irritation set up by it, and on the depression of the powers of life consequent on the effort made by nature to rid the system of a spoiled member. But when the constitutional disease is the primary affection, and when the gangrene is consecutive to and dependent upon this, it would clearly be useless to cut off the mortified part, as the same morbid action might and would be set up in the stump or elsewhere. Hence the broad question of amputation in cases of gangrene turns upon the fact of the mortification being local or constitutional in its origin.

When the gangrene is *local*, therefore, we usually amputate at once. This is especially the case when the mortification results from severe injuries, or is the result of the wound or ligature of an artery. Here, I think, for the reasons which

have been given (p. 198), that amputation should be performed as soon as the gangrene has unequivocally manifested itself, without waiting for the line of demarcation. The result of amputation for traumatic gangrene, is, on the whole, very unfavorable; the patient very commonly sinking from a recurrence of the disease in the stump, or from the constitutional disturbance that had previously set in. Those cases are especially unfavorable in which the areolar tissue of the limb is much infiltrated and disorganized; the affection indeed partaking more of the characters of constitutional disease, with some forms of which it is closely associated.

There are two exceptions to the rule of amputating in traumatic and local gangrene before the occurrence of the line of demarcation; viz., gangrene from frostbite, and that from severe burns. In these injuries it is better to wait for the formation of the line of separation, and then to fashion the stump through or just above it as the circumstances of the case require.

In gangrene from *constitutional* causes, it is a golden rule in surgery never to amputate until the line of separation has formed; for, as it is impossible in these cases to say where the mortification will stop, the amputation might be done either too high, or not high enough; and, in any circumstances, the morbid action would to a certainty be set up in the stump. It is not even sufficient in cases of this kind to wait until the line of demarcation has formed before removing the limb; these spontaneous or constitutional gangrenes having often a tendency to remain stationary for some days, and then, creeping on, to overstep the line by which they had at first appeared to be arrested. Besides this, the local disturbance and inflammation set up by the amputation might be too great for the lessened vitality of the system or part, and might of itself occasion a recurrence of the gangrene. Hence in these cases it is always well to wait until the line of separation has ulcerated so deeply that there is no chance of the gangrene overleaping this barrier, at the same time that means are taken, by the administration of tonics, nourishing food, &c., to improve the patient's strength and fitness for the operation. So soon as this has been done in a satisfactory manner, and all the soft parts, except the ligaments, have been ulcerated through, the mortified part should be separated by cutting through the remaining osseous, ligamentous, or tendinous structures, and then means should be taken to fashion the stump that has been formed by nature. In some cases this will be sufficiently regular to serve every useful purpose after it has cicatrized; in most instances, however, the stump is more irregular in shape and unsightly in appearance, of which the accompanying drawing (Fig. 182) is a good illustration; and it will be found that the bones protrude to such an extent, or that the ulceration has affected the soft parts so irregularly, that it will be necessary, in order to give the patient a useful limb, to amputate through the face of the stump, or higher up. All this must be left to the discretion of the surgeon; but no procedures of this kind should be undertaken until the patient's strength has been restored sufficiently to bear the operation.

Fig. 182.

Spontaneous amputation in gangrene of right foot and left leg from plastic arteritis.

In *senile gangrene* it has been proposed to amputate the thigh high up. This practice has been successfully adopted by Garlike, James of Exeter, and others, and certainly appears to deserve a trial in all cases in which the health is otherwise good and the constitution tolerably sound. It has not as yet been adopted in a sufficient number of cases to warrant a positive opinion on its merits; but it would appear that, for it to succeed, the amputation should be done high up in the thigh, so that there may be a better chance of meeting with a healthy condition of the vessels and good vitality in the limb; the operation being performed on the principle, that this form of gangrene is dependent on local disease obstructing the vessels of the part, and not always on constitutional causes.

CHAPTER XXXI.

GANGRENOUS DISEASES.

BED-SORES.

When a part of the body is compressed too severely, or for too long a time, even in a healthy constitution, it loses its vitality, and a local limited slough results; this separates, and an ulcer is left, which cicatrizes in the usual way. But in certain deranged states of the health, more especially when the blood is vitiated, and the constitutional powers lowered, as during fever, or when the heart is diseased and weakened in power, more particularly if the patient be old, debilitated, or paralyzed, the skin covering those points of the body that are naturally and necessarily pressed upon in the recumbent position, such as the sacrum, the trochanters, the elbows, shoulders, and heels, becomes congested and inflamed, assuming a dull reddish-brown color, and speedily becomes excoriated without any pain being felt by the patient. It is not so much the actual severity of the pressure that occasions a bed-sore, as moderate long-continued pressure applied to a part congested by position in a patient enfeebled by disease or want. If means be not taken to improve the patient's health and strength, and to relieve the part from the injurious compression to which it is subjected, and more especially if it be irritated by the contact of feces or urine, the subcutaneous areolar tissue corresponding to the inflamed patch will be found to have become widely softened and doughy, being converted, with the skin covering it, into a tough grayish slough, from under which a thin ichorous pus exudes. This slough may extend by a process of undermining of the integuments covering it; and on its separation extensive mischief will be disclosed, the fascia and tendons being exposed, or the bones laid bare, and soon becoming roughened and carious. In some cases, even the inferior aperture of the spinal canal may be laid open, and death may result from a low form of arachnitis, in consequence of the irritation spreading to the membranes of the cord. In other cases the patient dies worn out by discharge and irritation.

Treatment.—This is in a great measure of a preventive character. When a patient is likely to be confined to bed for many weeks, especially by an exhausting disease, steps should be taken by proper arrangement of the pillows, and by the use of the water-bed and cushions, to prevent pressure from being injuriously exercised upon any one part. At the same time, cleanliness and dryness should be carefully attended to by proper nursing, by the use of a draw-sheet, and furnishing the bedstead with the necessary arrangements of bed-pan, &c. The skin on the exposed parts may be protected by the application of collodion or soap-plaster spread upon wash-leather or amadou, or isinglass or felt; or, what is better, it may be strengthened by being washed with spirits of wine, either pure or having two grains of bichloride of mercury dissolved in each ounce.

If the skin have become chafed, the removal of pressure is imperative, and the abrasion may be washed over with collodion; if a sore have formed, it may be dressed with the balsam of Peru, either pure or diluted with the yelk of egg spread upon lint. In these cases also the use of the prone couch may occasionally be advantageously substituted for that of the ordinary bed previously employed. When sloughs have formed, their separation must be facilitated by the use of charcoal or chlorinated poultices, and the ulcers that are left should be dressed with astringent and aromatic applications, such as catechu, tincture of myrrh, &c.; but no dressing that the surgeon can apply will cause these ulcers to clean, and still less to heal, unless the patient's general health improve, and then they will speedily recover under the most simple treatment.

SLOUGHING PHAGEDÆNA.

This affection, which is also commonly known by the names of *hospital*, *contagious*, or *pulpy gangrene*, is characterized by a rapidly destructive and spreading ulcer, covering itself as it extends by an adherent slough, and attacking open sores and wounds. It is rarely met with in its fullest extent, except in military practice; the accumulation of a large number of wounded with suppurating sores under one roof, and the want of the necessary cleanliness and attention during an active campaign, disposing to it. Overcrowding of a hospital is the most fertile cause of this disease. It used formerly to desolate the civil hospitals; but, thanks to the sanitary measures now so generally adopted in these institutions, it has almost disappeared from them, though still an outbreak of it occasionally takes place. During the last few years, it has been met with in most of the London hospitals, and has twice made its appearance in that of the University College.

Local Signs.—When sloughing phagedæna invades a wound that has hitherto been perfectly healthy, the surface of the sore becomes covered with gray soft points of slough, which rapidly extend, until the whole of the ulcer is affected. At the same time it increases rapidly in superficial extent, and commonly in depth; the surrounding integument becomes œdematous, swollen, and of a livid red color; the edges of the ulcer are everted, sharp cut, and assume a circular outline; and its surface is covered with a thick pulpy grayish-green tenacious mass, which is so firmly adherent to the sore that it cannot be wiped from it, being merely moved or swayed to and fro when an attempt is made to remove it. There is usually some dirty yellowish-green or brownish discharge, and occasionally some bleeding; the pain is of a severe burning, stinging, and lancinating character; and the fetor from the surface is considerable. The ravages of this disease, when fully developed, are very extensive. The soft parts, such as the muscles, areolar tissue, and vessels, are transformed into a gray pulpy mass, and the bones are denuded and necrosed. The larger bloodvessels resist the progress of the disease longer than any other parts, but may at last be exposed, pulsating at the bottom of the deep and foul chasm. There, is, however, little risk of hemorrhage taking place in the early stages; but, when the sloughs are separating, an artery may give way, and bleeding to a dangerous or fatal extent ensue. Hennen states that there is most danger of this happening about the eleventh day. When the sloughs are thrown off, in the form of reddish-brown or grayish-green, viscid, and pulpy masses, a very sensitive granulating surface is left, having a great tendency to bleed, and to be again invaded by the sloughing action.

Blackadder has described an ulcerated form of this affection, in which a vesicle containing a bloody ichor forms, with a hot stinging pain; this breaks, leaving a circular ulceration of about the size of a split pea. The ulceration, once formed, rapidly extends by sharp-cut edges into the surrounding integument.

On the two occasions in which I have had the opportunity of witnessing outbreaks of this disease in University College Hospital, the surface of the wound affected became rapidly covered with a yellowish-gray pultaceous slough. In some cases there was hemorrhage; but most commonly a small quantity of fetid discharge only was poured out, the edges of the sore became sharp-cut and defined, and the ulceration extended further in the skin by an eighth or a quarter of an inch than in the subjacent areolar tissue. In the majority of instances the disease was confined to the skin and areolar tissue, exposing but not usually invading the muscles and bones, though in some cases these were affected. The ulcers, which had a somewhat circular shape, were surrounded by dusky inflamed areolæ of some width. When once the morbid action was stopped, they cleaned rapidly, throwing out large vascular granulations.

Constitutional Symptoms.—These are inflammatory in the first instance, with a tendency to asthenic and irritative fever as the disease advances. In the majority of cases they follow the local invasion of the sore; Blackadder, Rollo, Delpech, and Wellbank have all found this to be the case, and in the instances at University College Hospital it certainly was so. Hennen and Thomson, on the other hand, state that the constitutional symptoms precede the local. This discrepancy of observation may be explained by the difference in the cause of the disease; if it occur from contagion, the constitutional symptoms will be secondary to the

local affection; if from causes acting on the general system, they may probably be primary.

All wounds and sores are liable to be attacked in this way, but the disease most frequently affects those that are of recent origin; the more chronic affections, and those that are specific, very usually escape.

Causes.—Primarily, this form of gangrene commonly originates from overcrowding of patients in hospitals. This I believe to be the great occasioning cause of hospital gangrene and sloughing phagedæna, more particularly if patients with suppurating wounds be overcrowded in the same ward or room. I believe that in this way the disease may at any time be produced. The last outbreak that occurred at University College Hospital was clearly referable to that cause, and to that cause only. In one of my wards, which is intended to contain 15 or 16 patients only, owing to accidental and unavoidable circumstances, 21 patients were admitted, and slept for one night, many of them having suppurating wounds. The result was an outbreak of hospital gangrene, which spread through the Institution, and was of the most serious and persistent character. Next to overcrowding, I believe that the most fertile causes of this disease are want of cleanliness and ventilation, and unchanged dressings. The accumulation, indeed, of animal exhalations arising from the sick and wounded, is a source of various forms of low fever and of allied diseases; and hospital gangrene, when it occurs in these circumstances, may be taken as evidence of the infringement of the sanitary laws in accordance with which the arrangements of the Institution should be regulated. But though it commonly has its origin in this way, especially in the crowding of military hospitals after a hard-fought action, it is met with out of hospitals. Well-marked cases of this affection, some of a very severe character, have at times occurred amongst the out-patients of University College Hospital. In these cases, as in many others, it is probable that the disease was occasioned by the neglect of hygienic conditions, in the close and ill-ventilated houses of the poor, aided possibly by some atmospheric or epidemic influence; influenza, erysipelas, and phlebitis being also very prevalent. This had been observed at the time of the first occurrence of the disease at our hospital, in 1841; and I think it is difficult not to recognize a similarity of cause in these different affections. When once it has occurred, it may readily spread by contagion, though there is no evidence to show that it is of an infectious character. Hence the necessity of preventing its spread through the incautious use of sponges by nurses or attendants, and of destroying the dressings used by the patients.

Treatment.—The first point to attend to is to *prevent the extension of the disease* to patients who are not as yet affected by it. This may be done by separating those who have been seized with it from the healthy, by preventing overcrowding of the hospital, ventilating the wards, washing the floors with a solution of the chlorides, whitening the walls, and fumigating the apartment with chlorine gas.

Local Treatment.—The *extension of the slough* must be stopped by the free application of fuming nitric acid, or of the actual cautery, to the edges and surface of the ulcer. I have used both these agents, but give the preference to the nitric acid, if strong and freely applied, the sides and edges being well sponged with it. The actual cautery is, however, very useful in those cases in which the surface to be destroyed is very extensive, or if there be a tendency to hemorrhage. Should it not reach the deeper portions of the sore, nitric acid may be freely sponged into them. It is important to bear in mind that these escharotic applications should be carried deeply, so as to affect the living structures lying beneath the tenacious gray pulpy slough, and that their action be not fruitlessly expended upon charring this, which is already disorganized. After the cauterization a strip of lint, soaked in a strong solution of the watery extract of opium, should be laid around the margin of the ulcer, so as to cover the surrounding areola; and the separation of the sloughs must be encouraged by the continued application of charcoal, yeast, or chlorinated poultices. When they have separated, and the surface of the sore has cleaned, it may be dressed with a lotion composed of one grain of the sulphate of copper, and five of the watery extract of opium to the ounce of water. The granulations, which are very luxuriant and vascular, will be found to skin over with great rapidity; and the cicatrix, like that of an ordinary burn, will contract very firmly.

[Hospital gangrene occurred frequently in the army hospitals of this country during the late war, and its treatment was very varied. *Bromine*, as an escharotic,

was especially advocated by Dr. Goldsmith, and was perhaps more extensively used than any other remedy. *Sugar* was successfully used by Dr. Packard, and *buttermilk* by Dr. W. F. Atlee. The plan which I myself employed was, after thoroughly cleansing the wound, to cauterize it freely with a solution of the permanganate of potassa (℥j—f℥j); afterwards dressing the part with a weaker preparation of the same salt (℥j—℥j), to which I sometimes added an equal quantity of alcohol. The cauterization was repeated each day, till the disease was checked.—A.]

Should *arterial hemorrhage* occur, it may be arrested by the application of a ligature to the bleeding point; but if this do not hold, as will probably be the case from the softened state of the tissues, the perchloride of iron or the actual cautery must be applied; or the limb must be at last removed, in the event of all other means failing.

In some cases it happens that, though the sloughing action is checked at one part of the surface, it has a tendency to spread at another. When this is the case, it may be necessary to apply the caustic or cautery repeatedly. In other instances, the sloughing action cannot be stopped, but opens large arteries, and destroys the greater part of the soft tissues of a limb; and then it may be a question whether amputation should be performed during the spread of the disease, or the patient left to die of hemorrhage or exhaustion. Such a contingency is not of common occurrence; yet it may happen and the operation be successful, as appears from the following case, though there would necessarily be great danger from a recurrence of the disease in the stump. The wife of a butcher applied at the hospital, with a slight wound of the forearm, inflicted by a foul hook. It was dressed in the ordinary way, but in the course of a few days she returned with extensive sloughing phagedæna of the part; she was immediately admitted, and the disease was arrested by the energetic employment of the local treatment above described; not, however until after considerable destruction of the tissues on the inside of the forearm had taken place. She left the hospital before the wound was completely cicatrized, and returned in a few days with a fresh attack of the disease, more extensive and severe than the first, which could not be permanently stopped, either by the actual cautery or by nitric acid. The radial artery was opened and required ligature, and the whole of the soft parts, from the wrist to the elbow, were totally disorganized, and the bones exposed. There was now very severe constitutional irritation, and the case was evidently fast hastening to a fatal termination. In these circumstances I amputated the arm midway between the shoulder and elbow; and, notwithstanding that the local disease was progressing at the time of the operation, and that great constitutional disturbance existed, the patient having a pulse of 160 to 170, at which it continued for more than a fortnight, she made a good recovery; to which the free administration of quinine and stimulants greatly contributed.

The *constitutional treatment* of this disease must have for its object the removal of the combined state of debility and irritation in which we find the patient. The bowels should be opened, if necessary, by warm aperients; as nourishing a diet as the patient will take, with a liberal supply of stimulants, should be ordered; and these may be increased by the addition of the brandy-and-egg mixture, or of ammonia, in proportion as depression comes on. At the same time, I have found great advantage from the administration of a mixture of carbonate of ammonia, gr. v; chlorate of potass, ℈j; compound tincture of bark, ℥j; decoction of bark, ℥iss, every four or six hours; or, if the patient will bear it, from five to seven grains of the sulphate of quinine every four or six hours, with a full dose of opiate at bedtime, or more frequently if there be much pain and irritation.

GANGRENOUS STOMATITIS, OR CANCRUM ORIS.

A peculiar phagedænic ulceration closely resembling the last-described affection is occasionally met with in the mouths of ill-fed children living in low and damp situations, most commonly occurring between the second and sixth or eighth years, but more especially about the period of the second dentition.

The mildest form of this affection presents itself as small, deep, and foul grayish ulcers, situated on the inside of the lips or cheeks, and attended with a red spongy condition of the gums and much fetor of the breath. In these cases, good food and air with nourishing diet, the administration of bark, with the chlorate of potass,

and the use of chlorinated lotions, with the honey of borax, will soon bring about a cure. The Spanish snuff (*sabilla*) applied to the sore mouth, or placed in a small cambric bag on the tongue, has a very good effect in cleansing these sores, and especially in soothing irritation.

Signs of Cancrum Oris.—In the more severe form of the affection, the true *cancrum oris*, we find, commonly during convalescence from some of the eruptive diseases of childhood, or after the incautious administration of mercury during a weak state of the system, that one of the cheeks becomes swollen, brawny, tense, and shining, being excessively hard, and presenting a red patch in its centre. In consequence of this swelling, it is often difficult to open the mouth; but if the surgeon can gain a view of its inside, he will see a deep and excavated foul ulcer, opposite to the centre of the external swelling, covered with a brown pulpy slough. The gums are turgid, dark, and ulcerated; the saliva is mixed with putrescent matters; and, as the ulceration in the mouth extends, the swelling sloughs, and a large, dark, circular gangrenous cavity forms in the cheek, opening through into the mouth; during all this time the child suffers little, but, as the disease advances, it commonly becomes drowsy, and at last dies comatose. When fully developed, this affection is most fatal. Rilliet and Barthez state that not more than one in twenty cases recovers.

Treatment.—The treatment is that of hospital gangrene. The sloughing mass should be deeply cauterized with nitric acid, but not with the actual cautery, lest the cheek be destroyed; the mouth should be syringed with the dilute solution of the chlorides; and the system supported with beef-tea, wine, and ammonia, in doses proportioned to the age of the child. After the cure of the disease, the cheek may be deeply cicatrized, contracted, and rigid, much in the same way as after a burn, requiring possibly some plastic operation in order to enable the child to open its mouth properly.

BOILS.

A *boil* is a hard circumscribed tumor of a violet or purplish-red color, flattened, though somewhat conical, suppurating slowly and imperfectly, and always attended by a small conical central slough of areolar tissue called a *core*. It consists of an inflammation of the subcutaneous areolar tissue and of the under surface of the true skin. The tension and hardness accompanying this affection render it extremely painful and annoying to the patient. It is most commonly seated in the thick skin of the back, the neck, or the nates.

Causes.—Boils most frequently make their appearance in young people, but are common enough at all ages, and are usually seen either in very plethoric or in very enfeebled constitutions, often following some of the more severe febrile diseases, and attending convalescence from them. In other cases, the system appears to have fallen into a cachectic state, often without any evident cause, and this terminates by a critical eruption of boils. A sudden change in the habits of life, as from sedentary to active pursuits, a course of sea-bathing, &c., will also occasion them. They are commonly met with in the spring of the year, but may occur at all seasons, and are occasionally epidemic, as has been the case during the last few years in London. When once they take place they are often extremely tedious, crop after crop continuing to be evolved. In many cases they must be looked upon as salutary, as being the means adopted by nature to rid the patient of morbid matters that are sources of irritation in, and might, if retained, become sources of disease to, the constitution. Hence, after an outbreak of boils, the health often greatly improves.

Treatment.—The *constitutional condition* of the patient, on which the disease is dependent, requires to be carefully attended to. No one remedy is capable of curing boils. The disease is the result, in some cases, of faulty or defective nutrition; and the gradual modification and improvement of those processes that are subservient to it are necessary before the local eruptive affection will cease to appear. In other instances, it appears to be due to want of proper elimination of effete materials from the system. Hence less is often to be expected from medicines in these cases, than from a general regulation of the hygienic condition of the patient. Nature will do more for his recovery than art; and the utmost that the practitioner can do is to administer such remedies as will assist in the improvement of his con-

stitutional condition. If he be debilitated and cachectic, iron, quinine, sarsaparilla, and cod-liver oil; if he be plethoric, and his system loaded, purgatives, salines, and liquor potassæ will be appropriate. In the one case an abundant nourishing diet, in the other case a spare and simple one, with avoidance of stimulants, will be required.

In some cases, empirical means are of service. Thus, when the disease is associated with pompholyx, or preceded by painful vesicles, arsenic may be of benefit. In other instances yeast or charcoal has been advantageously given.

The *local treatment* of boils is simple. When they are forming, the most useful dressing is a warm spirit lotion kept applied with lint and oiled silk; as suppuration comes on, a linseed-meal poultice, either simple or made with port wine, may be advantageously applied. Most commonly the boils may be allowed to break, when they discharge a thick pus, together with the central core, thus leaving a small cavity in and under the skin, which, however, soon fills up. The surgeon may in some cases find it necessary to open them by a crucial incision when they are large, and do not appear disposed to break of themselves. When the boil commences as a small irritable pustule, it may occasionally be kept back by touching the point of this with nitrate of silver, or with a saturated solution of bichloride of mercury.

CARBUNCLE.

A *carbuncle* consists essentially of a circumscribed and limited inflammation of the subcutaneous areolar tissue, rapidly running into suppuration and slough. Indeed, the rapid formation of pulpy grayish or ash-colored sloughs of the areolar tissue is characteristic of the disease, whether resulting from the specific nature of the inflammation, or more probably from the strangulation of the parts by the accumulation of serum and blood consequent on violent inflammatory action in parts the vitality of which has by constitutional depressing causes been previously materially lowered.

Signs.—A carbuncle usually begins as a small pointed vesicle situated on a hard base of a dusky red color. There is generally from the first a hot, burning, stinging, heavy or throbbing pain in the part, out of proportion to the apparent gravity of the disease. The contents of the vesicle speedily become puriform, and are shed. The inflamed base then rapidly enlarges as a flat, painful, hard, but somewhat doughy, circumscribed swelling of the integuments and subjacent areolar tissue. The swelling is of a dusky red hue, slightly elevated, but never loses its flattened circular shape; as it increases in size, the skin covering it assumes a purple or brownish-red tint, becomes undermined, and gives way at several points, forming openings through which ash-gray or straw-colored sloughs appear, and from which an unhealthy purulent discharge scantily issues. The size of the swelling varies from one to six inches in diameter; most commonly it is about a couple of inches across. Carbuncles are generally met with on the posterior part of the trunk, more especially about the shoulders and the nape of the neck; being rarely seen anteriorly, or on the extremities. I have, however, had to treat very large carbuncles situated on the abdomen, and have met with them on the skin, forearm, forehead, lips, and cheeks.

The *constitutional disturbance* attending this disease is always of the asthenic type; the complexion is often peculiarly sallow or yellow, the pulse feeble, and tongue loaded; and if the tumor be large, or be seated on the head, a fatal termination may take place, the patient sinking into a typhoid state.

Causes.—A carbuncle usually arises without any assignable local exciting cause; but in some cases it is evidently directly occasioned by the introduction of some poisonous matter into a puncture in the skin or a hair-follicle. In all cases it is associated with and dependent upon a disordered, usually a low, state of the constitution. Any condition that lowers the powers of the system will predispose to, and may at last occasion, carbuncle. Habitually bad and insufficient food, the exhaustion induced by chronic wasting diseases, as diabetes, albuminuria, &c., or the debility resulting from acute febrile diseases—more particularly typhus—may all occasion it. Carbuncles are more common in the old than in the young, and in men than in women.

Diagnosis.—This affection, with many points of resemblance, yet differs from *boils* in its greater size, in the dusky red of the inflamed integument, in its broad flat character, and in the large quantity of contained slough in proportion to the small amount of purulent discharge, as well as in the conditions in which it generally occurs.

The Prognosis in carbuncle will depend on the size of the swelling, on its situation, and on the state of the patient's constitution, more particularly on that of his kidneys. The most dangerous carbuncles are those that are large, and situated upon, or that encroach on, the scalp; in fact, the more this structure is involved the greater the danger. If the constitution be good, even these may be recovered from; but if the kidneys be unsound, or if there be chronic saccharine diabetes, the progress of the disease cannot readily be checked, and the patient will usually sink.

Treatment.—The *constitutional treatment* must be conducted on the general principles that guide us in the management of low and sloughing inflammations. After the bowels have been cleared out, the patient should be put on ammonia and bark if much depressed, or else the mineral acids and quinine. The latter in large doses, as much as five grains every four hours, is often of great service. Our great reliance in the more severe forms of the disease is, however, in the free administration of dietetic stimulants and good nourishment. The best medicine in such cases is undoubtedly port wine or porter, given as freely as the patient can take it. The mode of employment of stimulants is of great importance in these cases. As a general rule, that stimulant will agree best to which the patient is accustomed during health. Beer and wine should not be given together, but either will go well with brandy. In addition to stimulants, good and abundant nourishment should be given; meat, if the patient can digest it; if not, soups, such as strong beef-tea, essence of meat, or turtle-soup. The brandy-and-egg mixture is also especially serviceable.

Local Treatment.—In the very early stage of the formation of a carbuncle, when the disease appears as a small, angry, pointed vesicle situated on a hard brawny base, the further progress of the malady may often be completely arrested by opening the vesicle, and rubbing its interior with a pointed stick of potassa cum calce or nitrate of silver. If the carbuncle have attained a somewhat larger size, though still small, the wisest plan is to cover it with a piece of soap-plaster spread on leather, having a hole cut in the centre, through which the pus and sloughy matters may be discharged. Beyond this, nothing will be required. When of larger size, it should be poulticed. In these cases the question will arise as to whether it should be incised or not; and, if incised, in what way the operation should be practised. Some surgeons uniformly adopt incisions; others again, with equal constancy, reject them. I think that the exclusive employment of either method is erroneous, and that the most successful treatment consists in allowing the question of early incision to be determined by the amount of tension existing in and around the carbuncle. Should the parts be soft, relaxed, and comparatively painless, no advantage can result from incision; but, on the other hand, if the tension be considerable, the agony great, and the constitutional disturbance dependent on both proportionately intense, nothing gives such immediate relief, local and constitutional, as early and free incision. This may be practised in two ways. It may be done subcutaneously, by entering a long bistoury at one side of the carbuncle, and making two or three subcutaneous sweeps through the inflamed tissues at different planes in depth. Or it may be done by a free crucial cut, carried fairly through the diseased parts into the healthy tissues beyond them. By either method the constitutional disturbance accompanying and resulting from the extreme tension is at once removed, the local progress of the disease is checked, and extension of sloughing by strangulation of the tissues is prevented. Should recourse not have been had to early incision of the carbuncle, it may become necessary at a later period, in order to prevent the confinement of the pus and slough. Poultices are now to be applied; these may be simply of linseed-meal and water, or they may be made more stimulating by the addition of port wine, yeast, or beer-grounds. As the sloughs loosen, they should be separated; and the granulating surface which is left, and which will usually be found to be sluggish in its action, should be dressed with some of the more stimulating ointments, such as those of elemi, resin, or balsam of Peru. The ulcer, though large, will, when thus treated, cicatrize rapidly, and will leave but a small scar.

[Carbuncles may often be well treated without incision, by *pressure* with strips of adhesive plaster applied in a concentric manner. The slough will be squeezed out through a small central aperture with very little loss of substance. This mode of treatment is attended with very little pain, and requires much less time than is needed for the healing of the wounds of large crucial incisions.—A.]

CHAPTER XXXII.

ERYSIPELAS.

ERYSIPELAS is an affection that so frequently and seriously complicates most other surgical diseases and injuries, that its study is of the utmost importance to the practical surgeon. It usually manifests itself as a peculiar and distinct form of inflammation; as much so as any of the other varieties—the adhesive, the suppurative, the ulcerative, or the gangrenous. Erysipelas, or, as it may be termed, the *erysipelatous inflammation*, including all those varieties of this condition that are usually spoken of as "*diffuse*," has a remarkable tendency to spread or diffuse itself with great rapidity by continuity of surface, to change its seat, and not to be limited by any adhesive action. It may extend itself over any continuous surface; the skin, the areolar tissue, the mucous and serous membranes, and the lining membrane of arteries, veins and lymphatics, are all liable to be affected by it. Hence, to describe it merely as a *cutaneous* disease, as has often been done, is in the highest degree incorrect and unphilosophical, and evinces a very limited acquaintance with its true nature. It simply affects the skin more frequently than other membranous surfaces, because the skin is more frequently than any other surface in the body the seat of wounds—the most common exciting cause of this disease. Indeed, not only must we look upon erysipelas as a disease that may affect any surface, external or internal, but we must consider the constitutional disturbance that takes place in erysipelas as the essential morbid condition. This, it is true, is usually complicated with diffuse inflammation of the integument and areolar tissue, and then constitutes one of the ordinary forms of erysipelas. But a constitutional fever may occur, of precisely the same type as that which we observe to precede and to accompany the local inflammation, without any such complication. This I had special occasion to observe in a very fatal outbreak of erysipelas that took place in one of my wards some years ago. On that occasion, all the cases in which the cutaneous form of erysipelas appeared were marked by severe constitutional disturbance, attended by much gastro-intestinal irritation. But precisely the same type of general febrile symptoms, and the same irritation of the stomach and bowels, occurred in patients in the same ward in whom no local or surface evolution of the disease took place, as in those affected by the ordinary cutaneous form of it. The true pathology of the diffuse, low, or erysipelatous inflammations has yet to be made out. They are all closely connected with one another, and are evidently blood or constitutional diseases, under whatever name they go. The similarity of causes, of effects, and of constitutional disturbance, makes it probable that they are all essentially dependent on one common condition of the blood; and that the particular local manifestation that occurs, whether it be erysipelas, phlebitis, low cellulitis, or diffuse abscess, is secondary to this, and perhaps in some degree accidental.

A chief characteristic of this erysipelatous fever is its incompatibility with the localization of any inflammation that may exist at or occur after its invasion; and hence, when it attacks the system, it causes already existing inflammations to assume a diffuse or spreading character, extending themselves over any surface on which they happen to be situated. It is, in fact, the very antithesis of the adhesive inflammation; and not only is it so, but it is antagonistic to that process. When erysipelas attacks a wound in which this process has made any progress, it has a tendency to disorganize the already deposited lymph, to open up the wound, and to lead to the establishment of suppurative action in it. It is especially apt to cause those inflammations to spread which have not already been localized, by the deposit of adhesive matter. Hence, recent wounds are more liable to be affected by it than old, and more especially granulating ones, in which the inflammation has already taken on a plastic character, which requires to be overcome before the diffuse form can set in.

The constitutional fever in erysipelas, although usually at first of the sthenic

form, very speedily runs into an asthenic or irritative type, presenting in severe cases the usual typhoid symptoms—a quick feeble pulse, brown tongue, pungent hot skin, and muttering delirium. The disease is truly an affection of debility; it is in consequence of the want of a sufficient degree of power in the part, or in the system, for the deposit of plastic matter, and the limitation of the inflammation by this, that the local affection spreads itself unchecked along the surface it invades. The tendency that invariably exists in erysipelas to the occurrence of sloughing and suppuration of the affected tissues, is a further indication of the asthenic and low character of the disease. This view of the nature of the constitutional disturbance in erysipelas is of great importance in reference to the treatment of the disease, as it demonstrates the necessity of not lowering the patient's powers too much during the early period of the affection, when it often temporarily assumes a truly sthenic character.

Erysipelas is especially apt to become complicated with low visceral inflammation; the membranes of the brain, the bronchi and the lungs, or the gastro-intestinal mucous surface, are commonly implicated in this way; and it is often through these complications that death results.

Causes.—Erysipelas may occur without any external wound, injury, or lesion of any kind, being occasioned by some external agency, such as cold acting injuriously on a system previously disposed to its occurrence by habitual derangement of health. Or it may be directly excited by the infliction of a wound in an individual who is either strongly predisposed to its occurrence by previous constitutional derangement, or who is after the receipt of this injury exposed to circumstances that favor the development of the disease. Erysipelas may be predisposed to by two distinct sets of causes: 1. Those that are *intrinsic* to the patient—that are constitutional, dependent upon the state of his general health; and 2. Those that are *extrinsic*—those conditions of life to which he has habitually been exposed, or by which he is surrounded after the injury or operation to which he has been subjected.

1. *Intrinsic Causes.*—The great predisposing cause of erysipelas is to be sought for and will be found in a *want of attention to those hygienic conditions* that are necessary for the maintenance of health or that should surround a patient; and is one of the penalties inflicted by nature on those who neglect those prime requisites of health—temperance and cleanliness, or who are incapable of obtaining good food and pure air. Were the laws of hygiene attended to as they should be, erysipelas and the allied diffuse inflammations would scarcely be met with in surgical practice. Some persons appear to be *naturally predisposed* to erysipelas to so great a degree, that the application of cold, or slight stomach derangement, or a trivial superficial injury, may excite it. This predisposition is most generally acquired by habitual derangement of health, and is especially induced by any of the depressing causes of disease, such as over-fatigue, anxiety of mind, night-watching, and habitual disregard of hygienic rules as to diet, exercise, air, &c. The habit of body, however, in which erysipelas is most frequently met with as a consequence of very trivial exciting causes, is that which is induced by the habitual use of stimulants to excess. It is more especially in that state of the system characterized by an admixture, as it were, of irritability and of debility, in which no plastic lymph is deposited as the result of inflammation, but in which this condition is followed by a rapid tendency to the formation of pus and slough, and to extension of disease in a diffuse form, that erysipelas is so very readily induced. This condition of body is met with amongst the laboring poor, as the result of the privation of the necessaries of life, conjoined with the habitual over-use of stimulants and exposure to the various depressing causes of disease, arising from bad food, impure air, &c. Amongst the wealthier classes it occurs as a consequence of high living, want of exercise, and general indulgence in luxurious and enervating habits, leading to imperfect depuration of the blood, in consequence of which that fluid is loaded with effete materials.

Some *diseased states of the blood* appear to predispose, in the highest degree to the supervention of erysipelas. This is especially the case in diabetes, and in granular disease of the kidneys attended by albuminuria. As a consequence of renal disease, erysipelas will occur idiopathically, or from the most trivial causes; a scratch, the sting of an insect, or any of the minor operations in surgery, more especially about the lower part of the body, will occasion it. And not only is it readily induced in this way, but it will extend in an uncontrollable manner in these

states of the system, and will often assume a gangrenous form, there being apparently in them an utter want of limiting or reparative power in any inflammation, however set up. So also persons of a gross and plethoric habit of body, with a tendency to gout, are predisposed to the occurrence of erysipelas. The blood-degeneration that occurs as a consequence of malignant disease peculiarly disposes to erysipelas, which accordingly more frequently takes place after operations on persons having such diseases than after the removal of simple tumors.

Persons whose nervous systems are habitually depressed, the semi-idiotic and idiotic, for instance, are very prone to low diffuse and sloughing inflammations of an erysipelatous form.

2. *Extrinsic Causes.*—Amongst the circumstances that surround the patient, and that tend to the production of this disease, *season of the year* and *atmospheric changes* exercise a marked influence. Not only is erysipelas much more frequent in the spring and autumn than at other seasons of the year, but we not unfrequently find it coming on suddenly on the setting-in of cold easterly winds, or on the occurrence of sudden atmospheric vicissitudes. So also erysipelas often assumes an *epidemic* character, as the result of those peculiar but, at present, inexplicable conditions of the atmosphere, in which disease generally assumes a low type, and in which epidemic catarrhs, influenza, phlebitis, and other allied affections, prevail. Epidemic erysipelas is almost invariably of a low form, and is very commonly associated with some peculiar train of visceral complications that distinguishes the particular outbreak of the disease.

But not only is erysipelas epidemic; it is also *contagious.* The contagion of erysipelas, after having been repeatedly denied, can, I think, no longer be contested. Travers, Copland, Bright, Nunneley, and others, have adduced cases in proof of its contagious character; and instances have repeatedly fallen under my own observation, in which erysipelas, often unfortunately of a fatal form, has been communicated to the servants, nurses, or relatives of patients affected by it. A remarkable proof of the contagious nature of erysipelas occurred in the winter of 1851, in one of my wards at University College Hospital. The hospital had been free from any cases of the kind for a considerable time, when, on the 15th of January, at about noon, a man was admitted under my care with gangrenous erysipelas of the legs, and placed in Brundrett Ward. On my visit two hours after his admission, I ordered him to be removed to a separate room, and directed the chlorides to be freely used in the ward from which he had been taken. Notwithstanding these precautions, however, two days after this, a patient, from whom a necrosed portion of ilium had been removed a few weeks previously, and who was lying in the adjoining bed to that in which the patient with the erysipelas had been temporarily placed, was seized with erysipelas, of which he speedily died. The disease then spread to almost every case in the ward, and proved fatal to several patients who had recently been operated upon. In several instances patients were affected with the constitutional symptoms without any appearance of local inflammatory action, but characterized by the same gastro-intestinal irritation that marked the other cases.

Erysipelas may not only spread in this way from patient to patient, but any *diffuse inflammation*, as phlebitis, inflammation of the absorbents, low or puerperal peritonitis, and pyæmia, may give rise to external erysipelas, and in its turn be occasioned by it—a strong argument in favor of the allied nature of all these affections. Then, again, the *contact of dead or putrescent animal matters* with recent wounds may occasion it. In this way the disease is not unfrequently originated in hospitals by dressers going direct from the dead-house, and especially from the examination of the bodies of those who have died of diffuse inflammation, to the bedside of patients without taking sufficient care to wash their hands or change their clothes. For this reason also it is of great consequence that the same instruments be not used for practising operations on the dead, and performing them on the living body. *Overcrowding* of hospitals, and *want of proper ventilation* in wards or rooms, are fertile sources erysipelas, and of the allied low inflammations; in fact, I believe that an outbreak of erysipelas might at any time be induced in this way.

The principal *exciting cause* of erysipelas is certainly *the presence of a wound.* It is chiefly recent wounds, however, that are affected by it; when once the adhesive or suppurative inflammation is set up, the wound is not so liable to take it on unless it be in bad constitutions, the formation of limiting fibrine appearing to lessen the

liability to the occurrence of the disease. When erysipelas is epidemic, it is well for the surgeon not to perform any operation that can conveniently be postponed until it is less rife; and in no case should a patient on whom an operation has recently been performed be put in a neighboring bed to a case of erysipelas, or even in the same ward. The size of the wound has little influence on the occurrence of erysipelas, which takes place as readily from a small as from a large one. But although the mere size of a wound does not influence the liability to the occurrence of erysipelas in it, which will as readily follow a puncture as an amputation wound, yet its character does. Thus, lacerated wounds are much more liable to be followed by erysipelas than clean-cut incisions. And the depth of the wound influences in an important manner the severity of the erysipelas, which is more intense in those injuries that penetrate the fasciæ, even though this be cut to a very limited extent, when the disease may spread widely and fatally through the deeper subaponeurotic and intermuscular planes of areolar tissue. Injuries about the head and hands are those that are most liable to be followed by this disease.

But, though we must constantly bear in mind the constitutional nature of erysipelas, it will be more convenient and practical to describe it as it affects different tissues and organs. With this view, we may divide it primarily into external and internal erysipelas.

EXTERNAL ERYSIPELAS.

By *external erysipelas* is meant that variety of the disease which affects the skin and subcutaneous areolar tissue. This form of the affection has been described with an absurd degree of minuteness, so far as the transitory and accidental characters of its duration, shape, and appearance are concerned, by many of the writers on the diseases of the skin; who, in their anxiety to record minute and often accidental shades of difference in appearance, have entirely lost sight of the true nature of the disease. The division adopted by Lawrence into the *simple*, the *œdematous*, and the *phlegmonous* forms, is a practical arrangement that is commonly adopted by surgeons. I prefer, however, and shall adopt, the division made by Nunneley in his very excellent work on erysipelas, as founded on the true pathology of the affection. He arranges external erysipelas under, 1. The cutaneous; 2. The cellulo-cutaneous; and, 3. The cellular varieties.

1. **Cutaneous Erysipelas** is the slightest form of the disease, implicating merely the skin; it comprises many of the species of *erythema* of different writers, and corresponds to the *simple erysipelas* of Lawrence.

Local Signs.—A patient is seized with rigors, alternate chills and flushes, followed by headache, nausea, a quick pulse, a coated tongue, and hot skin; in from twenty-four to forty-eight hours the rash appears, though sometimes it comes out simultaneously with the constitutional disturbance. If there be a wound, the secretions of this dry up, and the margins become slightly swollen, and affected by the red blush. If the disease occur idiopathically without a wound, it most commonly appears upon the face, next upon the legs, and lastly upon the trunk. The rash is of a uniform but vivid rosy red hue, sometimes becoming dusky, and always disappearing on pressure; it usually fuses away into the color of the healthy skin, but is sometimes distinctly margined. It is accompanied by some slight œdematous swelling, which is often considerable where the areolar tissue is loose, as in the eyelids and scrotum, and there is usually a stiff burning sensation in the part. Vesicles or blebs often form, containing a clear but hot serum, which speedily becomes turbid, and dries into brawny desquamation. The redness may spread rapidly along the limb or trunk, or, if the face be affected, may travel quickly from one side to the other, causing such swelling of the eyelids as to close them, and giving rise to much tensive pain in the ears. Sometimes the disease disappears in one part of the body, reappearing in another. This, which is the *erratic* erysipelas, is often a dangerous form of the affection, occurring in advanced stages of pyæmia, and indicating the approach of death. In these varieties of idiopathic erysipelas, Arnott states that the fauces are always involved. This affection usually disappears without inducing any serious mischief in the part affected, but in some cases abscesses form, more especially in the loose areolar tissue of the neck and of the eyelids. In other cases, œdema of the part continues, with some irritability and redness of the skin and peeling of the cuticle; and in some rare cases the simple erysipelas seems to take

on a gangrenous or sloughing character, especially about the umbilicus and genitals of young children.

The *constitutional symptoms* of the cutaneous or simple erysipelas present every variety between the sthenic and asthenic forms of inflammatory fever. When the disease occurs in London, it certainly most frequently assumes a low type. There is also in most cases a good deal of derangement of the digestive organs; the tongue being much coated, with tenderness about the epigastrium, dark offensive evacuations, and not unfrequently diarrhœa. When the scalp is affected, severe headache, with symptoms of cerebral inflammation, are commonly met with. Most frequently recovery takes place by the gradual subsidence of the symptoms; this form of the disease seldom proving fatal unless the scalp be affected, and the brain consequently implicated.

2. **Cellulo-cutaneous** or **Phlegmonous Erysipelas** differs from the last variety in the degree of inflammation, and in the depth to which the tissues are affected. The intensity of this form of inflammation is such as invariably to terminate, if left to itself, in diffused suppuration and sloughing of the tissues. In depth it invariably extends to the subcutaneous areolar tissue, and, though generally bounded by the fasciæ lying beneath this, not unfrequently implicates them if they have been opened up, extending to the intermuscular areolar planes, the sheaths of the tendons, and other deep structures of the limb or part.

Local Signs.—The cellulo-cutaneous or phlegmonous erysipelas is ushered in by the ordinary symptoms of inflammatory fever, accompanied or followed by the signs of severe inflammation in the part affected. The redness is uniform, of a deep scarlet hue, and pretty distinctly bounded; the pain is from the first pungent and burning, though it may soon assume a throbbing character; the swelling, at first soft, diffused, and admitting of distinct pitting, soon increases, and becomes tense and brawny, the skin being evidently stretched to its full extent, and the limb appearing perhaps to be double its natural size. Large vesications or blebs containing sero-purulent fluid, sometimes of a sanious tinge, make their appearance in many cases. This is the condition that usually continues up to the sixth or eighth day after the invasion of the disease, during the whole of which time the constitutional symptoms have presented the ordinary type of sthenic inflammatory fever; about this time, however, a change commonly takes place, either for better or worse. If, under the influence of proper treatment, and in a tolerably healthy constitution, the inflammation subside, resolution takes place, with a gradual abatement of all the symptoms. If, however, as usually happens, the disease run on to more or less sloughing or suppuration of the part, no increase of the swelling, pain, or redness takes place, but, on the contrary, some diminution of these signs may occur, giving rise to an apparent, though deceptive, amendment in the patient's condition. The skin becomes darkly congested, and the part, instead of being tense and brawny, has a somewhat loose, soft, and boggy feel, communicating a semi-fluctuating, doughy sensation to the fingers. This change from a tense brawny state to a semi-pulpy condition is indicative of the formation of pus and slough beneath the integument, and should always be anxiously watched for by the surgeon. It must be remembered that it occurs without any material change in the size, the color, or the general appearance of the part, but can only be detected by careful palpation of it; hence the surgeon must daily examine with his own fingers the state of the parts inflamed, and neither trust to the reports of others, nor to the general appearance of the diseased structures, for the probable condition of the subjacent tissues. If an incision be now made into the affected part, the areolar membrane will be found loaded with an opalescent fluid distending its cells, but not flowing from the wound; the retention of this fluid in the areolar tissue gives a gelatinous appearance to the sides of the incision, which rapidly degenerate into slough and pus. If the alteration in structure have advanced to a stage beyond this, the areolar tissue will be found to have been converted into dense masses of slough, lying in the midst of thin and unhealthy ichorous pus; these have not inaptly been compared in appearance to masses of decomposed tow, of wet chamois leather, or to the membranes of a fœtus a few months old. Whilst these changes are going on below the surface, the skin, at first congested, becomes somewhat paler, and assumes a white or marbled appearance, rapidly running into black sloughs, and being undermined to an immense extent by large quantities of broken up areolar tissue and of ill-conditioned pus, without any appearance of pointing, however extensive the subcutaneous

mischief may be. These destructive changes expose muscles, fasciæ, and blood-vessels, and may induce necrosis of the bones or destroy the joints. They occur most readily in those parts of the body that possess the lowest degree of vitality, and hence are more common in erysipelas of the legs than in the same affection of the scalp. If the patient recover, there will be tedious cicatrization of the deep cavities that are left, or considerable œdema, often of a solid character, a kind of false hypertrophy of the part, which may continue for some considerable time. In other cases, again, there may be such extensive local destruction or gangrene of the soft tissues, with exposure and death of the bones or suppuration of the joints, that amputation of the limb may be required as a means of saving the patient's life. No operation of this kind, however, should ever be practised for the consequences of erysipelas, unless these be strictly localized, with no tendency to spread, nor until specific constitutional fever has been completely removed, except such as is of a hectic character, and dependent on the exhausting influences of the suppuration and disorganization of the tissues.

During the progress of these local changes, the *constitutional symptoms* have assumed corresponding modifications. At first of an active inflammatory character, the fever, when suppuration and sloughing have set in, often suddenly assumes an asthenic form; although in some cases there is no diminution in the severity of the symptoms, until, after an attempt for a few days to bear up against the exhausting influence of the disease, the constitution gradually gives way, and death speedily supervenes. If the patient survive the stage of sloughing, and if the discharge continue abundant, hectic, with diarrhœa, gastro-intestinal irritation, metastatic abscesses, or pyæmia, may carry him off. If recovery eventually take place, it may be at the expense of a constitution impaired and shattered for years. This disease is most dangerous in the old and infirm, or in young children. The immediate danger is always greatest when the head is affected, from the extension of the disease to the membranes of the brain, and the supervention of erysipelatous arachnitis. The remote danger from the effects of suppuration, necrosis, and inflammation of the joints, is greatest when the lower extremities are the seat of erysipelas.

A variety of the cellulo-cutaneous erysipelas has been described as *œdematous erysipelas*. By this is meant not merely the effusion into the areolar tissue which occurs in all the varieties of the disease, but a peculiar form, specially marked by œdema of the areolar tissue, with less inflammation of the skin than usual. There is much swelling, which pits deeply, with but little pain or tension, and but moderate redness of the skin; the constitutional symptoms are less marked than in the other varieties of the disease: it is principally met with in old people, or in persons of a dropsical tendency, in whom it occurs especially about the legs, scrotum, or labia, sometimes giving rise, by the effusion of a sero-plastic fluid, to permanent and solid enlargement of these parts.

3. **Cellular Erysipelas**, or, as it is often termed, *diffuse inflammation of the cellular tissue*, or *cellulitis*, has been particularly described by Duncan, Arnott, Lawrence, and Nunneley. It always arises from a wound or injury, often, however, of an apparently trivial character, and most commonly affects the subcutaneous areolar membrane, though occasionally it extends to the subaponeurotic tissue, and then is a more severe and dangerous affection. Though commonly arising as a consequence of ordinary injuries, it is especially apt to follow those in which there has been any inoculation of animal poison, as dissection-wounds, the stings of insects, and the bites of venomous reptiles. In whatever way arising, it is characterized by the rapidity and extent of the sloughing of the affected tissue, and by great depression of the powers of the constitution. That the diffuse inflammation of the areolar tissue, whether it be limited to a finger, or implicate the areolar membrane of half the body, is a variety of erysipelas affecting this membrane primarily, and the skin secondarily, there can be no doubt. The points of resemblance between cellulitis and erysipelas have been well shown by Nunneley. Not only are the local effects precisely the same in the two diseases—the same swelling, tension, infiltration of pus, and formation of gangrenous shreds and sloughs; but the constitutional symptoms, though differing perhaps in degree, present no variety as to character. The results also are identical, there being the same local impairment of structure, the same tendency to involve parts at a distance, and to the formation of secondary abscesses. So also these two diseases occur in the same constitutions, in the same states of the atmosphere, and in the same situation; one form of disorder

may produce the other; and, lastly, the same treatment is required for both affections.

Local Signs.—These are great swelling, tension, and pain in the limb, which feels brawny in some parts, œdematous in others. The skin, which is slightly reddened in patches, has a mottled appearance, and speedily runs into blackish sloughs. The extent to which the disease may spread varies greatly; when once it has set in, it commonly runs rapidly up the whole of a limb, extending also to the sides of the trunk; in other cases, its violence appears to be principally expended at a distance from the seat of injury; thus, in a case of a punctured wound of the finger, the diffuse inflammation may principally take place in the extended planes of areolar tissue about the axilla and sides of the chest. It is important to bear in mind that this form of erysipelas sometimes affects the internal planes of areolar tissue. This may happen for instance, in the fasciæ of the pelvis after lithotomy, or in the anterior mediastinum after operations at the root of the neck. The sloughing often occurs with remarkable rapidity in the course of thirty-six or forty-eight hours, the areolar membrane being broken down into ill-conditioned pus and shreddy sloughs, more especially when the disease has resulted from the inoculation of an animal poison. Death may in such cases occur in two or three days; in other instances, again, several weeks elapse before a fatal result declares itself.

The *constitutional symptoms* are those of asthenic fever in the most marked degree; a quick and feeble pulse, brown tongue, and muttering delirium, being early concomitants of this affection.

Diagnosis.—The diagnosis of the various forms of erysipelas is generally easily made. From the *exanthemata*, it is distinguished by the character of the eruption, its limited extent, and usual complication with injury. From *inflammation of the veins or of the absorbents*, the diagnosis is not always so easy, more especially as the two conditions frequently coexist. If it be a vein that is inflamed, the general absence of cutaneous redness, the existence of a hard round cord, and the tenderness along the course of the vessel, are sufficient to establish the diagnosis. In inflammation of the absorbents, the redness will be found not to be uniform, but to consist of a number of small and separate red streaks, running in the direction of the lymphatics, and affecting the glands towards which they course. These two affections, however—erysipelas of the skin and inflammation of the absorbents—are almost invariably conjoined; hence a definite diagnosis is not of much importance.

Prognosis.—The prognosis in any case of erysipelas depends on a variety of circumstances. The *form of the disease* influences greatly the result; the cutaneous variety attended with least danger, the cellular with the most. The traumatic is more dangerous than the idiopathic form. Much, however, depends on other circumstances, such, for instance, as the *seat of the affection;* that attacking the head and lower limbs being the most dangerous; encephalitis being apt to ensue, when the head is affected. When the legs are extensively implicated, sloughing of the skin and areolar tissue, with denudation of the bones and destruction of the joints, may occur. The disease, in all its forms, is most dangerous at either of the *extremes of life.* The *previous state of health* of the patient also influences greatly the result. If the constitution be sound, very extensive mischief may be recovered from; if, on the other hand, it be depressed or broken by want of the necessaries of life, by fatigue, over exertion, or indulgence in stimulants, a very slight amount of disease may probably prove fatal. The most dangerous complication of erysipelas, and one which when it exists almost precludes the hope of recovery, is a *granular state of the kidneys* with albuminuria. I have never seen any patient laboring under this disease, and attacked with traumatic erysipelas, escape with life; the sloughing and suppuration running on unchecked by any treatment that could be adopted. The particular *type* which the erysipelas may assume, and the occurrence of gastro-intestinal or pulmonary complications, will also seriously affect the result.

Treatment. *Preventive Measures.*—The occurrence of erysipelas is best guarded against by attention to hygienic measures, more particularly to proper ventilation with pure air, and the avoidance of overcrowding of patients. In hospitals, erysipelas might be produced at any time by want of attention in these respects, and the frequency of its occurrence may most materially be lessened by careful regulation of the hygienic conditions that surround the patient. With every care it must, however, be borne in mind that erysipelas can never be completely eradicated from

surgical wards, as the conditions that lead to its development have influenced the patients so deeply before their admission into hospital, that no subsequent attention can prevent its occurrence afterwards. It will often be found that erysipelas is unusually frequent in certain wards and even in certain beds. Its persistence in these respects will be found to be owing to some local cause, such as the emanations from a drain, on the removal of which the disease will cease. Scrupulous attention to cleanliness also on the part of nurses and dressers should be enforced, and the latter should not be allowed to go straight from the dead-house to the ward without previously washing their hands in some chlorinated solution. When erysipelas has already occurred, its further spread may be prevented by isolating the patients affected, and at once taking active measures to purify the ward from which they have been removed.

The *curative treatment* of erysipelas must always be conducted with reference to the low character of the local inflammation, its tendency to run into suppuration and gangrene, the asthenic type that the constitutional fever readily assumes, and the frequent complication of the visceral inflammations of a congestive form. The apparent intensity of the local inflammation must not lead the surgeon into the fatal error of employing an over-active antiphlogistic treatment, more particularly if the disease be epidemic, when it always assumes a low type. In the treatment of this affection it is especially important to look to the future, and to remember that, if active depletory measures be employed early with a view of lessening the present disease, it will be at the risk of inducing more extensive sloughing, and perhaps of lowering the patient's powers to such a degree as to prevent his bearing up under the depressing influence of the consequences of the disease.

In the *treatment of cutaneous* or *simple erysipelas*, we must in the first instance clear out the stomach and bowels by an ipecacuan emetic, followed by a calomel and colocynth pill and some saline aperient. If the patient be young and robust, and the disease be of a somewhat sthenic character, he should be kept on a mild diet, and have diaphoretic salines administered every fourth or sixth hour. If the patient be advanced in years, and the disease assume a lower form, the acetate of ammonia in camphor mixture may be administered. If the disease from the first assume a low type, or if it subside into this, the carbonate of ammonia in ten grain doses should be added to the preceding mixture, in which the decoction of bark may then be substituted for the camphor julep. In many of the low forms of erysipelas medicines are not well borne by the patient, the stomach rejecting them; and then I have seen the best possible results follow the free administration of the brandy-and-egg mixture, to which I am in the habit of trusting in the majority of these cases. During the progress of the disease, simple purgatives must be given from time to time. In individuals of an anæmic and cachectic habit of body, no remedy exercises so beneficial an influence as the tincture of sesquichloride of iron. This should be administered in doses of twenty minims every third or fourth hour.

The *local treatment* of this, as of every variety of erysipelas, is of equal importance with the constitutional management. Warm applications assiduously continued, especially poppy and chamomile fomentations applied by means of flannels or spongio-piline, afford the greatest possible relief. Cold lotions should never under any circumstances be employed; they not only act injuriously by lessening the vitality of the part, and thus favor local sloughing, but they may chance to cause a retrocession of the disease, and the consequent affection of some internal organ. The local abstraction of blood and of serum from the inflamed part, by the plan introduced by Sir R. Dobson, of rapidly making with the point of a lancet a large number of small punctures, from a quarter to half an inch deep, is of much value, by lessening the tension and swelling, and consequently diminishing the inflammatory action; a warm fomentation cloth or poultice should be laid over the punctures so as to encourage bleeding, and the escape of serum. Astringent applications to the inflamed surface, such as a strong solution of the nitrate of silver, are recommended by some surgeons. I have seen them rather extensively employed by the late Dr. A. T. Thomson, but not with any very marked success. A boundary line of nitrate of silver is occasionally drawn around the inflamed part, with a view of checking the extension of the disease. I have often done this, and seen it done by others, but never apparently with any benefit; and have now discontinued the practice as an useless source of irritation. The application of a bandage is occa-

sionally necessary after the disappearance of the erysipelas, in order to remove the œdema that remains.

[A very good local application in cutaneous erysipelas is raw cotton. It seems to act simply by excluding the atmosphere, just as it does in cases of superficial burn.—A.]

In the *treatment of cellulo-cutaneous erysipelas*, more energetic constitutional and local means are required. In the early stage of the disease, our object is to prevent the inflammation from running into gangrene of the affected tissue. The fever being at this period commonly of a sthenic character, the more active administration of purgatives, antimonials, or effervescent salines is required. I have never seen a case in which bloodletting was required; and depressing remedies, such as salines, should be given with great caution. The best plan is, perhaps, to give an emetic and purge, to clear out the stomach and bowels, and then to give effervescing salines, with carbonate of ammonia, in full doses of gr. x to gr. xv. As the disease advances, and symptoms of more or less depression come on, it may be necessary to effect that gradual change to a more stimulating plan of treatment, which has already been described in speaking of the management of inflammatory fever. In doing this, the pulse and the tongue must be our guides; as the one becomes feebler and the other browner, so must ammonia, bark, and especially port wine, and the brandy-and-egg mixture, be administered. In the more advanced stages of the disease, when sloughing and suppuration are fully established, our sole object must be by nourishing diet, and the use of stimulants and tonics, more particularly the tincture of sesquichloride of iron, to bear the patient through the depression and subsequent hectic that ensue.

The *local treatment* of cellulo-cutaneous or phlegmonous erysipelas must be conducted on essentially the same plan as that of the cutaneous variety, though with the employment of more active means. The part affected must be kept at rest, must be elevated, if it be a limb, and have hot chamomile and poppy fomentations assiduously applied, cold being more prejudicial here even than in the last form of the disease; in this way, the swelling and tension may perhaps be removed, and the sloughing of the areolar tissue prevented. In the majority of cases, however, other means will be required to effect this, and with this view none are more efficacious than incisions made into the part; by these an outlet is afforded for the blood and effused serum, which, by distending the vessels and cells of the part, produce strangulation of the tissues and consequent sloughing. This mode of practice, originally introduced by Hutchinson, is generally allowed to be the most effectual means we possess for the prevention of sloughing; hence the incisions should be made early, before there has been time for the tissues to lose their vitality. So soon, indeed, as they have become brawny, indurated, and tense, incisions properly made and placed will afford the greatest possible relief to the part and the patient, taking down the tension by the gaping, and swelling by the exit they afford to blood and serum. Much difference of opinion has existed among surgeons, as to the extent to which incisions should be practised in these cases; some recommending that one long cut should be made through the inflamed structures; others contending, on the contrary, that a number of small incisions better answer the proposed end. The objections to the long incision are, that so considerable a wound not only inflicts a serious shock upon the system, but that the loss of blood from it is often so great as to be of serious, and even of fatal consequence to the patient—cases having occurred in which life has been lost from this cause, or the hemorrhage has been arrested only by the ligature of the main artery of the limb; and also that a single long incision does not relieve tension so effectually as a number of smaller ones. The incisions consequently should be of limited extent, from two to three inches in length; at most they should not extend deeper into the gelatinous-looking subcutaneous areolar tissue, unless it happen that the disease have extended beneath the fascia, when they may also be carried through it. South recommends that the incisions should be so arranged in fours, as to inclose a diamond-shaped space, and states that in this way the greatest relief is given to the tension of the part. After the incisions have been made, the part should be well poulticed and fomented, so as to facilitate the escape of serum. As it is not the object of the surgeon to draw blood in these cases, any undue amount of hemorrhage should be arrested by plugging the wound. After suppuration and sloughing have taken place, as indicated by a boggy feel of the parts, free incision should be

made in order to let out pus and sloughs. After this, the skin will often be found to be greatly undermined, blue, and thin, with matter bagging in the more dependent parts; if so, egress must be made for it by free counter-openings. During the after-treatment, frequent dressing is necessary to prevent an accumulation of pus, and the sloughs must be removed as they form. Care should be taken not to destroy any of the vascular connections of the skin with subjacent parts; but, in order to get proper cicatrization, it will often be found necessary to lay open sinuses, or to divide bridges of unhealthy and blue integument stretching across chasms left by the removal of the gangrenous areolar tissue. If the loss of substance be great, the cicatrix that forms may be weak, imperfect, or so contracted as to occasion great deformity of the limb. In other cases, again, the diseased state of the bones and joints may be such as to call for ultimate amputation, either in consequence of the local deformity and annoyance, or in order to free the constitution from a source of hectic and of irritation. In all circumstances, the patient's health will usually continue in a feeble and shattered state for a considerable time after recovery from this form of erysipelas, requiring change of air and great attention to habits of life, a nourishing diet, &c.

In the *treatment of cellular erysipelas* it is usually necessary to administer stimulants early; ammonia, wine, or brandy may be required from the very first. The surgeon must judge of this by the constitutional condition of the patient, and more particularly by the state of his pulse and tongue. The *local treatment* is precisely of the same kind as that adopted in phlegmonous erysipelas, except that the incisions require to be made earlier and perhaps more freely; in all other respects, there is no difference between the general management of the two forms of the disease.

Special Forms of External Erysipelas.—*Erysipelas of newly-born infants* is occasionally met with, more particularly in lying-in hospitals, or in situations where the mother and child are exposed to depressing causes of disease. It usually makes its appearance a few days after the birth, at first about the abdomen and genitals, but spreads rapidly over the whole of the body, being characterized by a dusky redness, which rapidly runs into gangrene of the affected tissues. It has been supposed to arise from inflammation of the umbilical vein, or of the umbilicus itself. It is an extremely fatal affection, owing to the feeble vitality of the child, and presents but few points for treatment; change of air and of nursing, with the administration of a few drops of spirits of ammonia or brandy from time to time, being all that can be done.

Erysipelas of the orbit may occur primarily, or as the result of extension of the morbid action from the neighboring structures. It is a dangerous and often fatal affection, from the occurrence of encephalitis. It commences with a violent deep-seated pain at the base of the orbit; the conjunctiva becomes injected and ecchymosed, the eyelids are greatly swollen, red, and œdematous; the eyeball protrudes, and vision is disturbed or lost. Symptoms of cerebral inflammation now set in, and the patient becomes delirious and often sinks comatose.

The *treatment* consists in fomentations, with early and free incisions into the orbit, made by pushing a lancet flatwise between the eyeball and the orbital walls, through the inflamed conjunctiva, the eyelids having previously been everted. In this way inflammatory effusions and possibly pus may be evacuated. Destructive abscesses of the orbit, possibly of an erysipelatous origin, occasionally occur in the puerperal state, requiring, when practicable, the free evacuation of the pus, in the way just mentioned.

Phlegmonous erysipelas of the head is of very frequent occurrence from slight injuries or operations about the scalp and face, more particularly in elderly people and those of unhealthy constitution. In this form of erysipelas there are two special sources of danger; one is sloughing of the occipito-frontalis muscle, the other, inflammation of the membranes of the brain. The occipito-frontalis rarely sloughs, except in cases of traumatic erysipelas of the head. It then loses its vitality in consequence of the suppuration of the deep plane of areolar tissue lying between it and the cranium, and the encephalitis occurs apparently by the extension of the inflammation inwards.

The *prognosis* of erysipelas of the head will often greatly depend upon whether it is traumatic or idiopathic. When arising from wound, it is very commonly fatal; when it is idiopathic, it is very seldom indeed followed by death. This difference in

the termination of the two varieties of the disease is owing, I believe, to the great tendency to suppuration and deep sloughing of the scalp in cases of wound, and the infrequency of this occurrence when there is no breach of surface.

In the *treatment* of this affection, active antiphlogistic means are more frequently required than in the management of other forms of erysipelas. But in very many, perhaps I may say in the majority of instances, the disease will be associated with more or less asthenia, and then the tonic and stimulating plan of treatment will be attended by the best results. With the view of preventing sloughing of the muscles, a free crucial incision should be made through the scalp down to the bone, the head, of course, having been shaved at the onset of the disease. Bagging of matter must be prevented by free counter-openings, and the application of pads and bandages, wherever it is likely to occur. However much the scalp may be undermined, or the bones of the cranium exposed, adhesion usually takes place, and the vitality of the parts is preserved.

Erysipelas of the scrotum, the "inflammatory œdema," so well described by Liston, is of frequent occurrence, as the result of wounds, ulcers, and other sources of irritation in this neighborhood. In this affection the scrotum swells to a large size, being uniformly red, but with a semi-transparent glossy appearance, pitting readily on pressure, and feeling somewhat soft and doughy between the fingers; the integuments of the penis are also greatly swollen and œdematous, and sometimes the inflammation extends to the areolar tissue of the cord. The chief characteristic of this form of erysipelas is its tendency to run into slough without any previous brawny or tense condition of the parts; the dartos becoming so distended with sero-plastic fluid that the circulation through it is arrested, and its tissue loses its vitality. When an incision is made into it in this state, it scarcely bleeds, and the sides of the wound present a yellowish-white gelatinous appearance.

The *treatment* of erysipelas of the scrotum is simple; it consists in making a free incision about four inches in length from behind forwards on each side of the septum, taking care, of course, not to go so deep as to wound the testes; the part must then be supported on a pillow, and well poulticed and fomented. If this incision be not made at once, a great part, or even the whole of the scrotum, may slough away, leaving the testes and cord bare; in these unpleasant circumstances, however, the parts will often with great rapidity cover themselves with a new integument. The œdema of the penis usually subsides of itself, or by making a few punctures in it; should its integuments, however, threaten to slough, a free incision must be made into it, or the prepuce be slit up.

Erysipelas of the pudenda is occasionally met with in ill-fed unhealthy children, in whom cleanliness is neglected. The parts become of a dusky or livid red, swell considerably, and quickly run into gangrene, which spreads up the abdomen or down the nates. It may prove fatal by inducing peritonitis or exhaustion. In the *treatment*, ammonia, bark, and the chlorate of potass, with good nourishment, and a little wine, are the principal means to be employed, at the same time that yeast or chlorinated poultices are applied locally.

Erysipelatous inflammation of the fingers, or, as it is commonly called, *whitlow*, is a frequent affection in old and in young people, either occurring spontaneously in cachectic constitutions, or as an accompaniment of renal disease, or arising from the irritation produced by scratches, punctures, or the inoculation of the part with poisonous or putrescent matters. It is most common in the spring of the year, when, indeed, at times it appears to be epidemic, large numbers of persons suffering from it without any very apparent local cause.

That whitlow is truly an erysipelatous affection of the fingers, appears to be the case, for the following reasons: 1. The causes, whether of season, infection, or local irritation, are the same in both affections. 2. The constitutional disturbance is always very severe for so slight a disease, and assumes the same character of speedy depression that we observe in erysipelas. 3. The inflammation of the affected finger is invariably diffused, never being bounded by adhesion, but always tending to terminate in suppuration and sloughing. 4. So soon as the disease spreads beyond the affected finger, or to the back of the hand, it assumes a distinctly erysipelatous appearance and character.

The inflammation of whitlow is in many cases confined to the pulp of the finger, commencing in the dense cellulo-fibrous tissue forming this, and often arising from a very slight injury, as the prick of a pin, a splinter, but not unfrequently without

any traumatic cause. The part becomes extremely painful, hard, red, and swollen; it then suppurates to a limited extent, with some sloughing of the areolar tissue. In many cases the ungual phalanx, which is imbedded in the cellulo-fibrous digital pulp, necroses when this sloughs. There is usually some inflammation of the lymphatics of the arm accompanying this affection, and not unfrequently a good deal of constitutional fever and irritation.

In the more severe cases of whitlow, the inflammation, which is of an excessively painful character, owing probably to the tension of the parts, extends to the sheaths of the tendons, and then constitutes an affection that is fraught with danger to the utility of the finger or hand. In these cases the whole finger swells considerably, becomes red and tense, with much throbbing and shooting pain; the inflammation rapidly extends to the back of the hand, which becomes puffy, red, and swollen, presenting the ordinary characters of erysipelas. Although the palm be greatly swollen, it usually preserves its natural color, or becomes of a dull white, owing to the greater thickness of the cuticle in this situation. Pus rapidly forms, both in the finger and hand, and, finding its way into the sheaths of the tendons, will spread up the forearm under the angular ligament. There is usually no fluctuation to be felt in the finger, even though pus may have formed, but in other parts of the hand it may readily be detected in the usual way. In these cases there is always much sloughing conjoined with the suppuration; the areolar tissue of the finger and hand, the tendons or their sheaths, and the palmar fascia, being all more or less implicated. In some cases the end of the finger, as far as the first phalangeal joint or the middle of the second phalanx, falls into a state of gangrene, and has to be separated. In many cases the joints of the fingers are destroyed, and the phalanges necrose; or, if this do not happen, the tissues of the part may be so matted together as the result of sloughing and suppuration, that rigid and contracted fingers, or a stiff and comparatively useless condition of the hand, may be permanently left.

In the *treatment* of this affection, the patient should be well purged, and kept upon a strictly antiphlogistic plan during the early stages. At the same time the inflamed finger should be freely leeched, and then alternately poulticed and soaked in very hot water for twenty-four or forty-eight hours, being kept during the whole of this time in an elevated position. In this way the inflammation may be sometimes cut short at its onset; should it, however, continue to progress, the finger becoming hard, with much throbbing, a free longitudinal incision must at once be made along each side of it, so as to relieve tension and prevent sloughing; this, though a painful procedure, should never be omitted, on account of the importance of the preservation of the full utility of the part. The incision is best made from the proximal towards the distal end of the finger, so that, if the patient make an attempt to withdraw the hand during the operation, he will rather facilitate the cut being made than otherwise. In making these incisions, however, the sheaths should, if possible, be avoided; if these be opened, the tendons will probably slough, and the finger be left in a permanently extended and rigid state. The finger must then be well soaked in hot water, and poulticed. In this way the inflammation may be arrested, and sloughing happily prevented; should, however, matter have formed, this must be let out as it accumulates, and all hardened and soddened cuticle peeled from the part. After the opening has been made, and any slough which may have formed has come away, it not unfrequently happens that a large and fungoid granulating mass sprouts up; this will, however, gradually subside, as the swelling of the finger goes down and the inflammation abates. If the nail become loosened, it had better be removed, as it may otherwise keep up irritation; it must not, however, be torn off if adherent, but merely scraped and cut away so far as loose. When the whole of a finger is affected, the hand should be placed on a pasteboard splint so soon as the inflammation has been somewhat subdued, lest contraction of the affected finger ensue, which may eventually extend to the neighboring ones.

When the joints are implicated, destruction of the cartilages commonly ensues; yet, by position, and rest on a splint, a tolerably useful though stiffened finger may be left. When the bones are implicated, some operative procedure usually becomes eventually necessary. If the ungual phalanx alone be necrosed, it may be excised through an incision on the palmar side of the finger, the pulp and the nail being left; in this way I have often preserved a finger that must otherwise have been removed. Amputation of the finger at the metacarpo-phalangeal articulation will

usually be required when the second or proximal phalanges are involved; though here partial operations, by cutting and scraping away the diseased bone, may sometimes be usefully done. During the later stages of these affections, tonics, good diet, and stimulants will be required for the re-establishment of the health.

INTERNAL ERYSIPELAS.

By *internal erysipelas* we mean those forms of diffuse inflammation which affect the mucous or serous surfaces, or the lining membrane of arteries, veins, and lymphatics

Erysipelas of Mucous Surfaces.—The mucous surface that is chiefly affected by this disease is that covering the fauces, the pharynx, or the larynx.

Erysipelas of the fauces may occur in consequence of the disease spreading from the head and face to these parts; or it may commence as a primary affection, occurring perhaps at the same time that the rash appears on the cutaneous surface on some distant part of the body. When the fauces are erysipelatous, they present a bright crimson or scarlet color, with some swelling and thickening of the soft palate and uvula; there is also most commonly some huskiness or complete loss of voice, and occasionally some croupy symptoms. At the same time there is a good deal of low constitutional fever, with a pungent, hot skin, and quick pulse. This form of erysipelas is of a peculiarly contagious character, and occurs not unfrequently in the attendants of those who are laboring under some of the other varieties of the disease; of this I have seen numerous instances. In many cases, also, it is epidemic, spreading through a house, and affecting almost every inmate.

Treatment.—The best results are obtained by sponging the inflamed parts freely with a strong solution of the nitrate of silver; and if there be much constitutional depression by administering full doses of ammonia, with camphor or bark. Should the disease go on to sloughing, constituting some one of the forms of "putrid sore throat" (which not unfrequently happens), the mineral acids and bark, with chlorinated port-wine gargles, and the brandy-and-egg mixture for support, will be found most useful. In many cases, this disease continues limited to the palate and fauces; but in others it extends either upwards or downwards. It may extend upwards through the nares, out of the nostrils, and thus spread over the face and head. It may extend downwards, affecting the gastro-intestinal membrane, or more frequently implicating the larynx.

Erysipelatous laryngitis, as described by Ryland, Budd, and others, is an extremely dangerous affection. The inflammation in these cases, commencing in the fauces, rapidly spreads to the mucous membrane and loose submucous areolar tissue external to and within the larynx, giving rise to extensive œdematous infiltration of these parts with sero-plastic fluid, which, by obstructing the rima glottidis, may readily suffocate the patient. In consequence of this special tendency to œdema, the disease has by many writers been termed "*œdematous laryngitis.*" After death, in these cases, the submucous areolar tissue of the fauces, that about the base and frœna of the epiglottis, and especially that which covers the posterior part of the larynx, will be found to be distended with serum or a sero-puriform fluid. This infiltration occupies the rima of the glottis, and extending into the interior of the larynx, gives rise to such swelling that its cavity is nearly obliterated. Great as the swelling may be, however, in all these parts, it never spreads below the true vocal chords. This fact, which is of considerable importance, is owing to the mucous membrane coming closely into contact with, and being adherent to the fibrous tissue of which these are composed, without the intervention of any submucous areolar tissue. The progress of this œdematous inflammation of the mucous membrane and loose submucous tissue in these situations, is often of an amazingly rapid character, the swelling being sufficient to induce suffocation at the end of thirty-six or forty-eight hours, or even sooner. If the patient be not carried off in this way, there will be a greater tendency to suppuration and sloughing of the affected tissues, leading perhaps eventually to death from absorption of pus, and low constitutional fever.

The *symptoms* of this affection are strongly marked. The patient, after being attacked with erysipelas of the fauces, attended by some difficulty and pain in deglutition, and huskiness of the voice, is seized with more or less difficulty in breathing, coughs hoarsely and with a croupy sound, and complains of tenderness under

the angles of the jaw and about the larynx. The difficulty in breathing increases, and may speedily threaten the life of the patient, giving rise to intense fits of dyspnœa, in one of which he will probably be suddenly carried off. On examining the throat from the interior of the mouth, the fauces will not only be observed to be much and duskily reddened, but by depressing the tongue the epiglottis can be felt, and perhaps seen, to be rigid and erect.

In the *treatment* of this affection, local means are of the first importance. The tongue having been well depressed, the posterior part of the larynx, the epiglottis, and its frœna, must be well scarified by means of a hernia-knife, with which this operation may be most readily and safely done. The patient should then be directed to inhale the steam of hot water, and a large number of leeches may be applied under each angle of the jaw, to be followed by large and hot poultices; at the same time, the bowels must be kept well opened, and the patient treated antiphlogistically or otherwise, according to the condition of the constitutional fever. Most frequently, in these cases, I have found antimonials of great service in the early stages, followed at a later period by support and stimulants. A few hours after the engorged tissues have been unloaded by scarification, the fauces, pharynx, and upper part of the larynx should be well sponged out with a strong solution of the nitrate of silver (℥j to ℥j) which must be applied freely, coagulating the mucus, and taking down the increased vascular action. If, notwithstanding the employment of these means, the dyspnœa increase, the face becoming pale, livid, and bedewed with a clammy perspiration, it will be necessary, in order to save the patient from impending suffocation, to open the windpipe. In doing this I prefer the operation of laryngotomy, for reasons that will be mentioned when I come to speak of the Diseases of and Operations on the Air-passages. In order, however, that this operation may be successful, it must not be too long delayed, and should not be looked upon as a last resource; if it be done in time (and time in these cases is most precious, owing to the rapid progress of the disease), the patient's life may probably be saved; but if it be deferred too long congestion of the lungs will come on, the blood will cease to be properly arterialized, and the patient will sink from a slow asphyxia, even though air be at last freely admitted. If the patient survive to the stage of sloughing, chlorinated gargles, bark, and support, must be our chief reliance.

Erysipelas of the Serous Membranes is of common occurrence in surgical practice, being frequently met with in the arachnoid and peritoneum. These, like all other serous membranes, are liable to two distinct forms of inflammation: one, which is of a sthenic character, having a tendency to the formation of plastic lymph; the other, which is of a diffuse or erysipelatous form, being always accompanied by the exudation of aplastic unorganizable fibrine.

Erysipelatous or *diffuse arachnitis* commonly occurs as a consequence of injuries of the head and erysipelas of the scalp. In these cases there are usually a flushed countenance, bright staring eyes, low muttering delirium, alternating with a comatose condition, and rapidly terminating in death; the constitutional symptoms are those of low irritative fever. On examination after death, the arachnoid and pia mater will be found greatly injected with blood, forming a close red network of vessels over the surface of the brain; the substance of which is usually somewhat injected, the ventricles being distended with a reddish-colored serum. If examined at a later period in the disease than this, the inflamed arachnoid will be found to be covered with a layer of opaque puriform lymph, of a greenish-yellow color and slimy consistence.

Erysipelatous or *diffuse peritonitis* is not unfrequently met with in aged and cachectic subjects after the operation for hernia, or as a consequence of various diseases and injuries of the pelvic or abdominal organs. In this form of peritonitis, the symptoms are often of a latent character, the disease being chiefly indicated by obscure pain diffused over the abdomen with tenderness on pressure, and an anxious depressed countenance, a hot skin, and a small and rather hard pulse. On examination after death, the subperitoneal areolar tissue will be found injected, the peritoneum opaque in parts, covered with filmy patches of grayish lymph, and usually containing a largish quantity of opaque dirty-looking turbid fluid, mixed with shreds and flocculi of lymph. This, though closely resembling pus in appearance, is serum with lymph intermixed, and is of a peculiarly acid, acrid, and irritating

character. It is this form of peritonitis that is so dangerous to dissectors; inoculation of the fingers with any of this fluid being often productive of the most serious and even fatal consequences.

Erysipelatous inflammation of the lining membranes of the vascular system will be fully discussed when we come to consider diseases of these parts.

CHAPTER XXXIII.

PURULENT INFECTION, OR PYÆMIA.

THE term *pyæmia* is applied to a group of pathological conditions, which, arising under somewhat similar circumstances, and running for the most part similar courses, were until recently considered to constitute a single well-defined affection dependent, as was supposed, upon the admixture of pus with the blood, hence the name given to it. This disease, for it will be found convenient to look upon the members of this group as constituting but one affection, is closely allied in cause and in character to some of the lowest and worst forms of erysipelas and diffuse inflammation, with which indeed it is commonly associated, and to which it presents great similarity in its causes, symptoms, and effects.

Causes.—Like erysipelas, pyæmia commonly occurs at those seasons of the year, and under those atmospheric conditions, in which diseases of a low type are prevalent. There is no more common or certain cause of its production than the overcrowding of patients suffering from suppurating wounds in hospitals; and it is in unhealthy and cachectic constitutions that it usually manifests itself. It is more common in adults and elderly people than in children; but, though it is least frequently met with during the earlier periods of life, it may make its appearance at any age: very young children and even infants may be carried off by it.

Pyæmia is a very common cause of death after operations and severe injuries, especially in hospitals that are situated in large towns or that are overcrowded. It is disposed to by all conditions of life either before or after operations or injuries that tend to impair the health, to lower the strength, and to induce an unhealthy state of the blood, such as habitual want of fresh air, overcrowding, and insufficient or impure nourishment. Of all these causes, overcrowding is undoubtedly the most frequent and the most fatal; more particularly is overcrowding of patients injurious if there be many suppurating wounds under the same roof. That pyæmia is the result of the faulty hygienic conditions just alluded to, viz., want of pure air, overcrowding, and insufficient and unwholesome diet, is evident from the fact of its being rife and most destructive where those causes of disease prevail, as amongst the poorer classes of all large and densely peopled towns; while in the purer air of country districts, or in private practice amongst the wealthier classes, it is rarely met with. It is one of those causes of death after operations that might and ought to be prevented; and wherever it is frequent, we may be sure either that the constitutions of the patients are peculiarly deteriorated, or else that the hygienic conditions to which they are exposed after the injury or operation are faulty.

Pyæmia is never, I believe, an idiopathic or primary affection, but either occurs subsequently to an injury or wound of some kind by which inflammation is excited, which has in most cases reached the stage of suppuration before the pyæmic symptoms come on; or appears in connection with some low form of specific suppurative inflammation. Thus we often see boils, carbuncles, diffused abscess, erysipelas of the skin, or erysipelatous inflammation of the veins or absorbents, precede its occurrence. Pyæmia is especially apt to occur, if decomposing pus be confined deeply amongst the tissues and unable to get a ready outlet. Wounds of veins, of bones, and of joints, are the injuries that are especially apt to be followed by this disease; and in the puerperal state it is often met with, probably as the result of uterine phlebitis.

Phenomena.—Pyæmia is characterized specially by two series of phenomena: 1. A peculiar train of constitutional symptoms attended by a state of great depres-

sion of the powers of the system; 2. The formation of abscesses in various parts of the body.

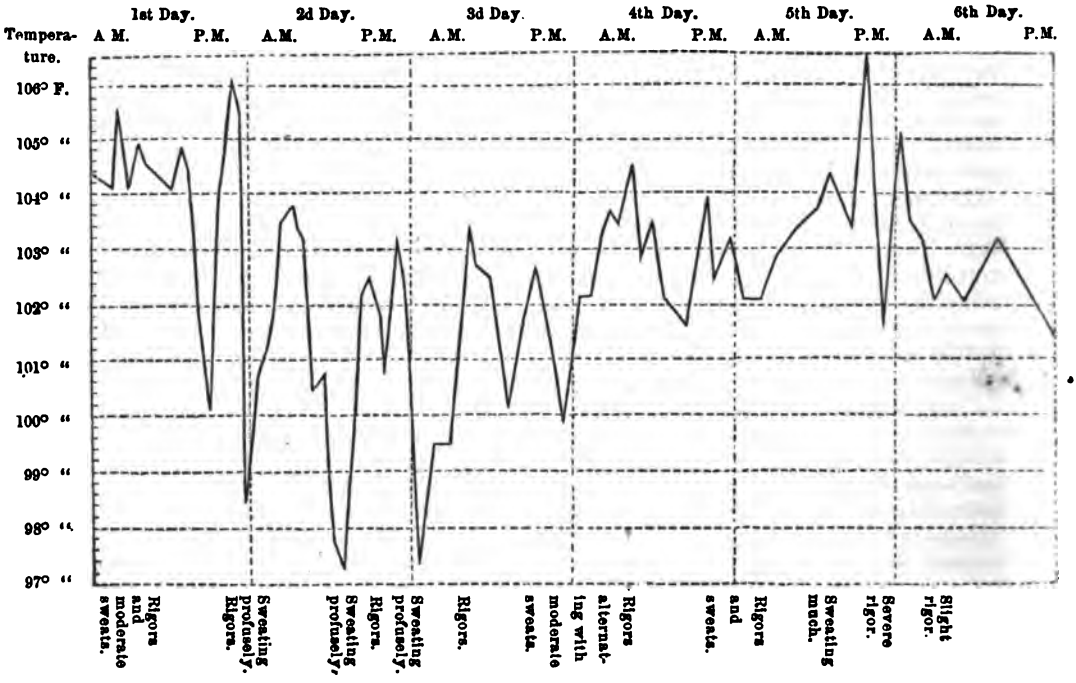
1. *Symptoms.*—The characteristic symptoms of pyæmia are sudden and severe rigors, accompanied, perhaps even preceded, by a great rise in the temperature of the body, and followed by profuse and exhausting sweats.

The invasion of the disease is as follows: During the period of an apparently ordinary febrile disturbance, the patient is seized with a rigor, usually very severe and prolonged. This is accompanied by a great rise in the temperature of the body, and is followed by profuse sweating, during which the temperature falls. The temperature will rise as high as 107° Fah.

The accompanying diagrams (Figs. 183, 184), for which I am indebted to Dr. Ringer, who took them from patients of mine, will indicate this more clearly than any description.

Fig. 183.

Temperature table in a case of pyæmia following primary amputation of the foot in a man aged 30.



A single rigor only may occur, and the disease pass off. But more frequently the rigors are repeated at intervals of from 24 to 48 hours; and, as the disease becomes established, they may recur twice or oftener in the 24 hours.

The *temperature of the body* in pyæmia presents remarkable and characteristic fluctuations. It is uniformly higher than normal, but rises above and falls in its general level in exact accordance with the development of the rigors. Dr. Ringer, who has paid great attention to this subject, believes that the rise in the temperature precedes the occurrence of the rigors, and has been able to predict the approach of a rigor by noting a commencing rise in the thermometer. It is a remarkable circumstance that this actual and great increase in the temperature of the body should coexist with a sensation of cold.

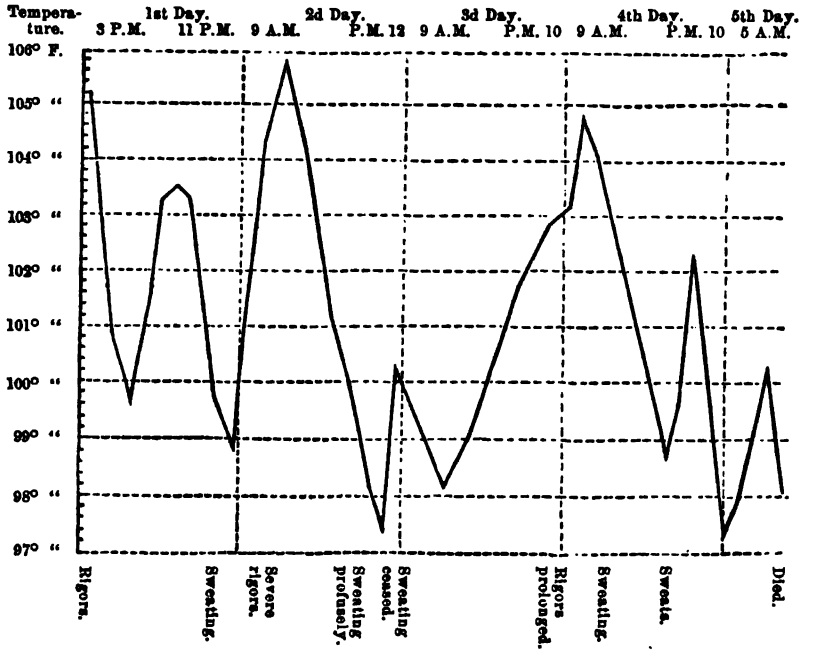
As the rigor subsides the patient breaks into a sweat—first about the face and head, then over the body. The sweats are usually very profuse, the bedclothes being soaked with perspiration. They are very exhausting to the patient. As soon as sweating comes on, the temperature begins to fall, and continues to decline until it reaches the uniform level.

The rigors, heat, and sweating, increasing at pretty regular intervals, cause an invasion of pyæmia closely to resemble that of an ague fit. And, indeed, there

would appear to be a close analogy between the two diseases; for, as ague is the result of blood-poisoning from exposure to malarial influences, and the introduction into the system of peculiar products of vegetable decomposition, or, if Salisbury be right, of vegetable organisms of a low grade, so pyæmia is the effect of contami-

Fig. 184.

Temperature table in a rapidly fatal case of pyæmia following a compound and comminuted fracture of the bones of the leg.



nation of the blood by the absorption into, or the admixture with it, of animal matters in a state of change that renders them capable of exercising a toxic influence on the body generally.

After the occurrence and repetition of rigors, heat, and sweatings, other changes begin to manifest themselves.

Any open wound that may exist at this time usually becomes foul and sloughy, and ceases to secrete healthy pus; but this is by no means necessarily the case, for it may continue healthily granulating throughout the disease. The skin is continuously hot, and has often a burning pungent feel. The breath has that peculiar sweetish, saccharine, or fermentative smell that is commonly noticed in all febrile diseases of a low type; this odor of the breath, and indeed of the body generally, often occurs early in the disease, and must then be taken as a very unfavorable sign. The secretions are arrested; the pulse is quick and soft; the face is usually pale, with a very anxious drawn look, but sometimes flushed, and the eyes bright; there are hebetude and dulness of mind, with slight nocturnal delirium, but perfect consciousness on being spoken to. Rapid wasting of the body sets in about this period; patches of erratic erysipelas frequently make their appearance on the surface; and the skin assumes a dull, sallow, and earthy, or a bright yellow icteric tint, which may extend even to the conjunctivæ. The symptoms now indicate an extreme depression of the vital powers, the pulse becoming small and fluttering, the tongue, which has been dry, becoming brown, with sordes about the teeth, and low delirium occurring. Usually from the sixth to the tenth day, but sometimes earlier, suppuration begins to take place in different tissues, joints, and organs. Abscess may form in the lungs or pleuræ without cough or pain; if seated in the areolar tissue, or in the substance of muscles, there is usually doughy swelling, with some redness; if in the joints, the swelling is often considerable, the pain usually intense and of a very superficial and cutaneous character, the patient screaming

aloud with the agony he suffers. These pains, which are chiefly seated in the knees, ankles, hips, and shoulders, often simulate rheumatism very closely, and have not unfrequently been mistaken for that disease.

The progress of the disease is usually from bad to worse, sometimes rapidly but at other times not uninterruptedly so, there being remission and apparent, though not real, improvement. The patient rapidly wastes, the body becoming shrunken, the muscles soft, and the skin gray or sallow, loose and pendulous; great debility also sets in. The abdomen becomes tympanitic, diarrhœa or profuse sweats come on; pneumonia or pleuritic effusions declare themselves; delirium, from which the patient is easily roused, alternates with sopor; and at last he sinks from exhaustion. Death usually takes place about the tenth or twelfth day; though it may occur as early as the fourth, or the patient may linger on for six or seven weeks.

In other cases pyæmia occurs in a very insidious manner, without severe rigors, but merely with prostration, and some low fever of an intermittent kind; after a time the skin assumes a yellow tint, as do the conjunctivæ. The urine is very high colored, and perhaps the peculiar odor in the breath or body may be noticed; but the patient continues in a quiet state, his wound being clean, and suppurating healthily. He gets, however, symptoms of low pneumonia or pleurisy, perhaps with pain and fulness in one joint, where abscess forms, and then the disease fully declares itself.

2. The *formation of numerous purulent deposits*, "secondary or metastatic abscesses," as they are often termed, is one of the most marked features of pyæmia. These abscesses usually contain a somewhat thin and oily-looking pus; at other times, however, it is thick and laudable. The more oily-looking fluid, though opaque and yellow, and closely resembling true pus, will, on microscopic examination, be found to differ from this in the absence of the true nucleated pus-corpuscles, though it contains an immense number of granular cells (Fig. 55). After removal it often forms a firm fibrinous coagulum. These purulent collections vary greatly in size and in situation. They are found in four localities, viz., in the viscera, in the areolar and muscular structures, in the serous membranes, and in the joints. They are most frequently met with in the lungs and pleuræ, usually in one pleural sac only; then in the joints; next in the intermuscular areolar planes.

Pyæmic abscesses differ from ordinary purulent collections, not only in the peculiar character of the pus that they contain, but more particularly in the rapidity with which they form, a few days commonly sufficing for them to attain a large size. So, also, their very widely spread character, and the insidious manner in which they occur, often with few if any local signs—the tissues, as it were, breaking down without any inflammation—constitute the distinguishing features of these collections.

The visceral abscesses vary in size from a pin's head to a walnut; in many cases the organs affected are studded with them. These collections are most frequently met with in the lungs, being seated at the posterior part and on the surface of these organs, or in the interlobular fissures; when occurring in the lungs, they are usually surrounded by a darkly inflamed and condensed layer of pulmonary tissue, and not unfrequently they are seated in the midst of a large patch of lung in a state of low or congestive pneumonia, or the whole of the posterior part of the lung may be in this condition studded with small pyæmic abscesses. The organ that is most frequently affected next to the lung is the liver. Here, also, the abscesses are usually small, numerous, and surrounded by an inflamed or congested areola of hepatic substance. In some cases, however, hepatic pyæmic abscess is single and of considerable size, perhaps as large as an orange. I have seen purulent collections in the spleen; but they are rare here, in comparison to the organs just named. They may occur in other organs; thus Gamgee has on several occasions observed them in the prostate.

When the pus is infiltrated into the areolar tissue and muscles of the limbs and trunk, it will form immense diffuse collections of a thin serous matter, commonly mixed with shreds of the areolar membrane of the part, having no boundary of limiting fibrine. These collections are most frequently met with, perhaps, in the axilla, down the flank and about the back, in the iliac fossa, thigh or calf, and may either be confined to the subcutaneous, or extend to the deep intermuscular, areolar planes in these regions; or they may even form in the muscular substance itself,

being diffused between the fasciculi, which are softened and disintegrated. Most commonly the presence of these collections is indicated by patches of cutaneous or erratic erysipelas, and by a doughy œdematous, and boggy state of the superjacent integuments.

Accumulations of pus and deposits of lowly organized lymph in and upon the serous and synovial membranes are very common in this disease; the pleura, the arachnoid, or the peritoneum may each be affected in this way. In the pleura especially, these accumulations are frequent, and pyæmic empyema will often occur very suddenly with few, if any, general symptoms or local signs to indicate its presence. Frequently some of the joints, especially the knees and shoulders, become filled with a thin, yellow, purulent liquid. These arthritic abscesses are usually indicated by the occurrence of intense pain, often of a cutaneous or superficial character, with fluctuation and swelling in the articulation affected. It often happens, however, that large accumulations of pus form suddenly in joints, without having been preceded by pain or any other sign of mischief; in these cases the interior of the joint, though filled with pus, will be found to be tolerably healthy, there being no erosion of cartilage or destruction of ligament, but merely some inflammatory injection of the synovial membrane.

Not only are the appearances just mentioned commonly met with in cases of death from pyæmia, but we find inflammation of the viscera, more particularly of the brain and lungs, and not unfrequently a diffused erysipelatous redness of some membranous surface, as of the arachnoid or the gastro-intestinal mucous membrane.

Diagnosis.—The diagnosis of pyæmia requires to be made: 1, from ordinary surgical fever, the inflammatory fever which accompanies wounds and injuries, especially when severe, and typhoid fever; 2, from ague; 3, from rheumatism.

1. The diagnosis from *ordinary surgical inflammatory fever and typhoid fever* is usually sufficiently easy, the course of these fevers being unbroken by severe rigors, by sudden fluctuations of temperature, or by sweats. These symptoms, which are so characteristic of pyæmia, do not occur in these other forms of febrile disturbance. An ordinary fever may be ushered in by a rigor; but this is seldom so intense as that which marks pyæmia, and certainly does not recur during the attack. The temperature also in ordinary fevers is uniformly and continuously high. It is not marked by those sudden exacerbations, followed by equally rapid declines, that are so marked in pyæmia. But it must be borne in mind that a pyæmic rigor may occur in the midst of the uniform high temperature of simple inflammatory fever, indicating the development of the blood-poisoning; but then the decline is only to and not below the previous high level, and, unless the pyæmia become established, the rigor and rise of temperature do not recur.

2. From *ague* the diagnosis would not be easy in the earlier stages, if the patient had been exposed to malarial influences as well as to the ordinary causes of pyæmia, as in a person injured whilst living in a swampy country. But in large towns, the general absence of ague and the obvious surgical cause of the pyæmia will render the diagnosis more easy. In the later stages, the signs of articular inflammation and suppuration, the secondary visceral and areolar abscesses, will all tend to clear up the diagnosis.

3. From *rheumatism* it is easy to make the diagnosis of pyæmia, provided the recurrent rigors and other early symptoms have been well and strongly marked. But if these have been somewhat obscure, and if the secondary articular implication be early developed, then it may certainly be difficult to determine the exact disease with which the patient is affected. But, independently of the recurrent rigors, the great prostration, the early supervention of atonic symptoms in these cases, the development of the visceral abscesses, of areolar suppuration, and of patches of erratic erysipelas, will establish the true nature of the disease.

[Between *pyæmia* and what is known as *gonorrhœal rheumatism*, there is a very close resemblance, if not, indeed, a pathological affinity. Intermediate to these, the various forms of constitutional disturbance which follow catheterization or other operations upon the urino-genitary organs, form a link which may conveniently be termed *urethral* or *genital fever*. *See Archives Générales de Médecine*, Mars, 1867, pp. 360–371, and *Am. Journ. Med. Sciences*, July, 1868, p. 217.—A.]

Prognosis.—The prognosis in pyæmia is always bad. The disease is dangerous to life, to health, and to limb. When active acute pyæmia has fairly set in, recovery rarely, if ever, takes place, the patient usually dying between the fourth and the

twelfth days. One or two pyæmic rigors may be recovered from. It is the repetition of these attacks, followed by profuse sweating, and attended by extreme exhaustion, that is so fatal. In fact, the danger and the rapidity of the fatal termination in any given case will, *cæteris paribus*, depend on the rapidity of the recurrence of the rigors and their severity.

When the pyæmic attack assumes from the first a subacute or chronic form, it may be recovered from, usually after prolonged illness, the formation of numerous or large abscesses, and great and continued disturbance of the general health.

In these less active and acute forms of pyæmia, one joint is liable to special implication, more particularly the knee, and next the elbow. The diseased action lighted up in it may go on to inflammatory disorganization. Suppuration of a destructive character may be set up in it, and loss or permanent impairment of utility of limb will be the inevitable result.

Pathology.—That the blood undergoes important changes in this disease is unquestionable, and there are many reasons for believing with Virchow, to whom we are indebted for much light on this subject, that at least three different conditions may present themselves; which, although probably coexisting in the majority of cases, yet have an independent origin, and may each prove the sole existing cause of some special symptoms, which, taken together, constitute the disease called pyæmia. These three conditions are:—

1. An increase in the number of the colorless blood-corpuscles, constituting the affection termed *leucocytosis*, which has been commonly viewed as a proof of the admixture of pus with the circulating fluid.

2. The formation of *thrombi*, and the changes which take place in them, leading to *embolism* or *metastatic deposits*.

3. An absorption of ichorous or putrid matter, and the commingling of this with the blood-stream, producing the condition called *ichorrhæmia* or *septicæmia*.

It will be desirable to consider these three conditions and their consequences *seriatim*.

1. *Leucocytosis*, or increase of the white corpuscles, with a corresponding increase in the amount of fibrine in the blood, is dependent upon an over action of the lymphatic glands, arising from an irritation applied to a part freely supplied with lymphatic vessels. The character of the irritation has, however, an important influence in determining the occurrence of this condition; thus, an erysipelatous or diffuse phlegmonous inflammation, affecting at an early period the lymphatic vessels and glands, may be expected to produce leucocytosis far more rapidly and certainly than a superficial inflammation of the skin due to traumatic or other simple causes. In consequence of the adhesive and segregatory characters of these white corpuscles they may often be found, when present, in considerable numbers, to be collected into masses or groups attached to the walls of the vein, thus giving rise to the belief that they are really pus-corpuscles, from which indeed they are absolutely indistinguishable, and that they are the products of inflammatory changes in the walls of the vessels. This may be well seen in any part where coagulation has taken place, the clot presenting a layer of milky whiteness due to the entanglement of the white corpuscles in the meshes of fibrine. It cannot be doubted that any considerable increase in the numbers of bodies possessing such marked powers of adhesion, both to one another and to the walls of the vessels, must tend to diminish the freedom of the circulation through the smaller vessels and capillaries, and thus facilitate the occurrence of stasis in the vessels. This condition of the blood seems to be connected with a state of general depression, and a pallor or a certain yellowness of the skin, but it appears doubtful whether it ever alone gives rise to the metastatic and secondary abscess so characteristic of the true pyæmic state; although after death large accumulations of the corpuscles, closely resembling small abscesses, may be seen in any organ which has been the seat of inflammatory or mechanical stasis. It is doubtful whether this condition is in any way connected with the formation of pus in the larger joints; recent experiments have, however, shown the possibility of the passage of the white corpuscles through the walls of the vessels, and their further development into pus-corpuscles, and thus this view appears sufficiently plausible.

2. The subject of *thrombosis* and *embolism* is one of the most important that can engage the attention of the scientific surgeon, as upon a full comprehension of the

circumstances attending these processes will in great measure depend his knowledge of the pathology of this disease.

The *causes* which lead to the formation of a thrombus or clot in a vessel are of three kinds, viz.:—

a. Retardation of the blood-stream due to (α) diminished *vis a tergo;* (β) diminished calibre in the vessel; (γ) interruption of the continuity of the vessel.

b. Changes in the condition of the wall of the vessel, or the presence of foreign bodies, due to (α) imperfect nutrition of the wall of the vessel, complete or incomplete; (β) injuries to the wall, or presence of foreign bodies.

c. Altered conditions in the blood itself, due to (α) leucocytosis; (β) septicæmia.

A thrombus forms more frequently in vessels of a medium size than in those of very large or very small calibre; and, as might be expected, more frequently in veins than in arteries of equal magnitude. The phenomena attending the formation of a thrombus in an artery have been already considered, and it will therefore only be necessary here to review those results of coagulation in the veins which are intimately connected with the subject before us. It will be desirable to consider the influence of these causes *seriatim.*

a. Diminished vis a tergo may result from want of power in the contractions of the heart, or from interruption to the proper distribution of the force, through want of elasticity in the arteries: the current of blood in the veins thus flowing with less rapidity, coagula are liable to form around the valves or in any dilatation which may happen to exist. Another very common cause of retardation consists in the *diminution of calibre* produced by the pressure of a tumor upon a vessel, or by the contraction following inflammatory exudation in the substance of an organ: examples of these conditions may be frequently seen in the iliac veins pressed upon by a pregnant uterus or an ovarian tumor, and in the vessels of a cirrhotic liver. The most important cause, however, is undoubtedly the *interruption of the flow of blood* which follows the division of a vein during a surgical operation. Several circumstances influence this result in an important manner; thus, if a vein be divided immediately below the site of a pair of valves, these being closed by the pressure from above, coagulation will take place in the column of blood thus rendered stationary; the clot may be limited or may extend to a considerable distance along the vessel, and not unfrequently small isolated thrombi form around the valves of the venous trunks leading from such an occluded branch. This process has been commonly described as phlebitis, the coagulation being viewed as secondary to the inflammatory changes in the coats of the vessel, which usually ensue sooner or later. These considerations offer a probable explanation of the evil effects which so frequently follow the application of a ligature to a large venous trunk, because, as a large column of blood is in these cases rendered stagnant, coagulation rapidly sets in and is not easily limited.

b. Amongst the second class of causes, *inflammation of the coats of the vessels,* arteritis and phlebitis, formerly occupied the most prominent position. Hunter described two forms, the suppurative and adhesive; and he considered that an exudation was thrown out upon the surface of the lining membrane, which acted as the exciting cause of the thrombosis. This has, however, been shown to be incorrect. The external coat may become inflamed, and the muscular coat suffers secondarily and becomes swollen, producing not only a narrowing of the calibre of the vessel but some irregularity on its inner surface. This may lead to coagulation; but, if the inflammatory action stop short of suppuration, the vessel may even regain its original condition without the formation of any clot; should, however, necrosis of the inner coat result, a thrombus rapidly forms upon the affected surface, and the vessel remains more or less permanently occluded. In the great majority of cases of phlebitis, however, the thrombus will be found to have been the cause of the inflammation, and not to have resulted from it. The deposit of fibrine which takes place upon the roughened walls of a degenerated artery must be considered as having a protective influence, and as tending to lessen the danger of rupture. The protrusion of *foreign bodies,* such as spicula of bone, or fragments of atheroma or fibrine, may give rise to the formation of a thrombus at any spot, and may be considered under the same head as embolism.

c. Among *changes in the blood* itself, which lead to the formation of thrombi, those conditions already described under the head of leucocytosis necessarily occupy an important position, as tending not only to diminish the rapidity of the

flow in consequence of the increased viscosity of the fluid, but to cause an increase in the amount of coagulable material or fibrine. It is doubtful whether this condition alone would suffice to produce coagulation in the vessels; it must, however, prove a powerful predisposing cause. It is probable, also, that certain septic conditions of the blood may tend to increase the liability to coagulation in the smaller vessels and capillaries in consequence of altered or arrested function of certain organs—lungs, liver, or kidneys. This is, however, probably the least important influence produced by septic conditions of the blood, which seem rather to lead to the softening and breaking down of the clots than to their formation.

Changes.—A thrombus, having formed, usually undergoes certain changes, either of a destructive or productive character, the results being classed as follows:—

a. Changes in the clot itself leading to organization, obsolescence, or softening and breaking down.

b. Changes in other parts due to the formation of the clot, viz., changes in the walls of the vessel and the establishment of the collateral circulation; or to the destruction of the clot.

The wall of the vessel usually contracts upon the contained clot, which gradually shrinks, becomes denser, more fibrillated, and ultimately penetrated by vessels. It may subsequently undergo calcareous degeneration leading to the formation of phleboliths, not unfrequently found in venous plexuses. The changes which end in disintegration produce, however, the most serious results, leading to secondary hemorrhage in the case of the arteries, and to blood-poisoning or metastatic deposits in that of the veins. The causes which lead to these changes are somewhat obscure, but are generally dependent upon bad hygienic surroundings and septic or epidemic influences. It is remarkable how very rapidly large clots may become disintegrated, and be washed away by the blood-stream in a state of minute subdivision, without producing any apparent results. Should, however, the fragments be of larger size, the phenomena of *embolism* are produced: these effects have been carefully studied by Virchow, to whose admirable researches science is indebted for an explanation of the results of these processes.

An *embolon* is a solid body which has entered the current of the circulation. It may consist of detached fragments of fibrine, calcareous, or atheromatous matter, foreign bodies or entozoa. The effects which it produces will depend upon its size, qualities, and upon the part of the circulation into which it may have entered. Thus it may become arrested in vessels of considerable size, or in the smallest arteries or capillaries; if it commence its career within an arterial trunk, it may become impacted in the smaller branches or in the capillaries of the systemic circulation; whereas, if it arise within a vein, it will probably be arrested in the branches of the pulmonary or the portal circulation. Sometimes, though rarely, the special characters of the embolon will enable the observer to decide as to what may have been its origin and course. It has been doubted whether a fragment of notable specific gravity entering the right side of the heart from the vena cava could be propelled into the branches of the pulmonary artery, and thus become impacted in the lung; the experiments of Virchow have, however, indisputably proved the possibility of this occurrence. It is to embolism that modern pathologists ascribe the formation of most, if not all, the metastatic abscesses found in the lungs of patients who have died pyæmic; and they consider that the embolon is derived rather from the destruction of pre-existing thrombi, than from the entrance of true pus into the circulation. Much attention has been directed to the question whether the admixture of pus with the blood necessarily leads to the occlusion of vessels, and the formation of capillary thrombi, and the inquiry can hardly be said to be exhausted. There can, however, be no doubt that, although the granular corpuscles of pus and blood are identical in their microscopic characters, they yet differ materially in their vital properties, and that the presence of pus in any notable quantities would lead to the occlusion of vessels and its consequences. The impaction of an embolon is indicated by the sudden occurrence of certain general symptoms, such as pain, numbness, or rigors; but the special symptoms will necessarily vary according to the organ affected; thus in embolism of the brain paralysis will follow, whilst in the lung dyspnœa is most prominent. The immediate local effect of the occlusion of a vessel is the production of intense congestion in the surrounding parts, which is usually followed by hemorrhage and the consequent production of the hemorrhagic infarcts so commonly seen in these cases; the changes which subsequently take

place in the part affected, will depend upon the facility with which the collateral circulation is established, and upon this also will depend in great measure the maintenance of its vitality. The appearance produced by these changes will vary with the structure of the particular organ in which they occur, with the character of its vascular supply, and with the exact point at which the body has become impacted. For a full account of these peculiarities the reader must consult special works on Pathological Anatomy.

It must not, however, be supposed that the occurrence of embolism and pyæmic abscesses stand invariably in the position of cause and effect: it is only under certain conditions at present imperfectly understood that the former may give rise to the latter. It is, indeed, a matter of common occurrence to find hemorrhagic infarcts in the spleen or kidney, or more rarely in the liver or lung, without there being any reason to suppose that the patient had, at the time of their occurrence, suffered from any pyæmic symptoms. It is highly probable that the character of the embolon itself has a marked influence in determining the subsequent results, and that simple mechanical obstruction never gives rise to the true metastatic abscess found in the pyæmic condition. Pyæmic abscesses may, morever, occur in an organ having no vascular connection with the part in which the original lesion exists, and under circumstances which render it impossible to conceive that any solid particles could have passed from the one to the other; we must, therefore, seek for some other cause to account for their formation, and this will lead us to the subject of blood-poisoning.

3. The third condition which is present in many cases of pyæmia, and which is probably the active cause of many of the symptoms, is that of blood-poisoning, *icorrhæmia* or *septicæmia*, due to the absorption of ichorous or putrid matter and its entrance into the circulation. That this is a condition actually present in many cases cannot be doubted; the adynamic or typhoid character of the symptoms, and the appearance of the blood after death, present unmistakable evidence of this fact. The question, however, of chief interest in connection with this subject is the mode in which this condition is produced; whether it be the result of the absorption of putrid matter from the wound itself, or of the softening and breaking down of coagula formed within the veins, or whether it be of the nature of a ferment which exists in the surrounding atmosphere and is absorbed through the lungs. Many arguments may be advanced in favor of each of these propositions; in fact, it is highly probable that the condition may be established in any of these ways; thus, in favor of the atmospheric theory, may be urged the fact that the disease occurs not unfrequently in patients who have nearly recovered, whose wounds are reduced to a minimum, and whilst these appear to be progressing favorably. [In a case of amputation of the forearm which occurred at the Pennsylvania Hospital some years ago, the first symptoms of pyæmia (which terminated fatally) were manifested a few days after the wound of operation had completely cicatrized. It is asserted by Mr. Savory, who has studied the subject very thoroughly, that pyæmia may occur not only without any pre-existing wound, but without suppuration or any local trouble whatever. (*St. Bartholomew's Hosp. Reports*, vol. iii. p. 77.)—A.] On the other hand, the first sign of the danger may appear in the changes which take place in the wound itself. It was long maintained, and as strenuously denied, that pus-corpuscles may enter the circulation by direct absorption from a suppurating surface; and, although there is no evidence that this ever does occur, yet recent researches upon the migration of the white blood-corpuscles through the walls of the smaller vessels, and their transformation into pus, would render this view possible at least. The theories advanced at various times by Hunter, Arnott, Bérard, and Sédillot, which, taking for granted the existence of pus in the blood, accounted for its presence by the supposition of a suppurative phlebitis, have already been disproved. But it is not unreasonable to suppose that the fluid portions of pus may be absorbed, and may lead to septic or other changes in the blood. The evil effects which follow the use of sponges in hospital practice, and the readiness with which infection may be thus carried, is a strong argument in favor of the local absorption of the poisonous material, an argument which has been still further strengthened by the successful application of the antiseptic principle in the treatment of wounds. The softening and breaking down of clots in the veins is so frequently connected with this condition of blood-poisoning, that it is difficult to determine whether it is to be looked upon in the light of cause or effect. That

clot-softening is a very common cause of metastatic abscesses, cannot be doubted; but this is in consequence of its giving rise to embolism, rather than to any septic influence upon the blood itself. As suggested above, it is not improbable, however, that the condition of septicæmia my give rise to the formation of abscesses in internal organs, apart from any influence it may exert upon preformed clots; but that these abscesses differ from those resulting from the impaction of embola, both in their distribution and in their anatomical characters, being never surrounded by that zone of hemorrhagic injection which almost invariably accompanies the latter.

Post-mortem Appearances.—After the above brief sketch of the more important pathological conditions which constitute the pyæmic state, the appearances to be found after death in any fatal case may be described.

The body usually changes rapidly after death, decomposition setting in at an early period; the skin is generally of a dirty yellow tinge, sometimes intensely jaundiced, with numerous spots of livid mottling, due to the occurrence of local congestion. Any external wound may present a gray sloughy or dry appearance; and dark red lines may be seen extending upwards, indicating the course of the veins or lymphatics.

The *blood* will often be found to be of a dark color, fluid, or imperfectly coagulated, although sometimes it may present no abnormal appearance whatever. Large numbers of white blood-corpuscles may be readily seen under the microscope, sometimes collected into masses, or entangled in a clot so as to give it a milky white appearance.

The *heart* is frequently the seat of small extravasations, which may be found either beneath the pericardial or endocardial lining, or in the muscular substance itself. Sometimes, though not very often, abscesses are found situated either in the wall or in the papillary muscles; these are usually small collections of puriform matter, rarely much larger than a pea, and often surrounded by a zone of congestion or hemorrhage. The muscular substance is flabby, and the lining membrane of both the heart and aorta is more or less deeply stained by imbibition of the blood-coloring matter. Pericarditis may result primarily from the formation of metastatic abscesses in the heart, but is usually secondary to the inflammation of the pleura, which is often very intense.

The *lungs* are much congested, especially at the posterior bases, where the tissue is friable; sometimes this congestion passes into true pneumonia, which almost always exists to some extent at least. The most important condition present in these cases is the existence of metastatic abscesses, which may vary much in number and size. These are commonly found scattered over the surface, and are almost invariably surrounded by a zone of condensed lung tissue, the result either of inflammatory action or hemorrhagic injection; and are still further surrounded by an area of active congestion. The position of these abscesses is usually indicated on the surface by a slight elevation; their form is most commonly wedge-shaped, the broader part or base being directed towards the surface. The central part of these masses consists of a gray slough, which may or may not have softened down into a grumous semi-fluid matter. The area of hemorrhage, measuring from one-eighth to half an inch in breadth, may present the ordinary characters of lung apoplexy, closely resembling damson-cheese on section, or it may appear of a tawny yellow color from partial reabsorption of blood-pigment. The size of these deposits varies greatly, from less than that of a pea to two or more inches in diameter. They are most commonly found on the posterior surface of the lower lobe, or in the interlobular fissure. The pleurisy which accompanies, and probably in most cases results from the formation of the deposit, is often very severe. The pleural surface is freely covered with patches of inflammatory lymph, whilst corresponding quantities of deeply colored turbid fluid are usually collected into the pleural sac. Sometimes, though rarely, small collections of pus are found scattered through the substance of the organ without affecting its pleural surface, or giving rise to any of the wedge-shaped masses above described.

The *liver* frequently presents no abnormal appearances, even in severe cases, where the lungs have suffered most markedly; in others, again, it is the seat of many abscesses, which often obtain a very large size. They have much the same character, both as to form and position, as those in the lungs, and are usually surrounded by a zone of hemorrhage and congestion. When, however, they occur as primary abscesses without any deposits in the lungs preceding them, they may

appear as simple collections of pus, having a more or less branched arrangement. This form of pyæmic deposit does not appear to be the result of embolism, but to be referable to those other conditions of ichorrhæmia or septicæmia which have been described above. It must be remembered that hepatic abscess may result from intestinal mischief, either of a typhoid or dysenteric character; and therefore the occurrence of this condition does not necessarily indicate the existence of general pyæmia.

The *spleen* is usually large, soft, very friable, and often of an almost pulpy consistence. Infarcts unconnected with the pyæmic state are frequently met with in this organ; metastatic abscesses are not, however, very common.

The *kidneys* probably stand next to the liver in the order of frequency with which they are affected. They are very frequently congested, and sometimes the seat of destructive nephritis; when abscesses appear, they present the same varieties as those found in other parts.

The *intestines* rarely suffer, but abscesses may be found in the submucous or subserous areolar tissue. Local peritonitis not unfrequently follows the formation of hepatic abscesses, and may become very severe. Of the other organs, the *prostate* is the most commonly affected; abscesses forming in the venous plexuses which surround this body. Metastatic deposits rarely form in the *brain*, although embolism of the cerebral arteries is not uncommon as a result of valvular disease of the heart.

One or more *joints* are usually found to be swollen and tender; and on opening them a large quantity of pale yellow or thick, flaky, and puriform fluid escapes. There are congestion of the synovial fringes, and softening or destruction of the cartilage.

The general character of the anatomical lesions present in this disease may be summed up as follows: A general tendency to local congestion, inflammations or extravasations of blood, accompanied by the formation of slough or abscess, due in the majority of cases to thrombosis or embolism, but in other cases to changes in the blood itself, which almost always presents remarkable fluidity, and a tendency to rapid decomposition.

Treatment.—The *preventive treatment* of pyæmia consists in a scrupulous attention to those hygienic measures which have been described in the earlier chapters of this work. But it is often distressing to the surgeon to feel that, whatever care may be bestowed upon the patient after an operation or accident, in these respects, the evil influences to which he has been exposed previously to its occurrence may have so contaminated his blood that pyæmia becomes almost an inevitable sequence of any suppurative inflammation that is set up.

In addition to ordinary prophylactic hygienic measures, there are a few of a more special character. Thus, pus should always be freely let out, especially if it be sanious, decomposing, or offensive. Quinine or iron may be given before an operation, or as soon after as the patient's condition will bear it; and a liberal supply of good nourishment enjoined. Disinfectants, especially carbolic acid and the chlorides, should be freely used. Some surgeons have advocated the internal administration of agents that have a special antiseptic character, as the hyposulphites; but their use does not seem to have been attended with the benefit that was expected from them on theoretical grounds.

The *curative treatment* of pyæmia is of the most unsatisfactory character. It doubtless happens that patients occasionally recover from this disease, even after the formation of diffuse abscesses; but such a result must be looked upon as a happy exception to its commonly fatal termination. The only plan of treatment that holds out any reasonable hope of success, appears to me to be the stimulating and tonic one, consisting of brandy or wine, ammonia, bark, and beef-tea; in fact, that plan of treatment which is usually adopted in low fevers and inflammations. I have certainly seen service done in some cases, and indeed recovery effected, by the administration of large doses of quinine; five grains being given every third or fourth hour, with the best effect. Beyond this I do not think it necessary to go. Among many others I may mention a very serious case of pyæmia following amputation of the arm, and accompanied not only by all the symptoms of that disease in a very marked degree, but by pleuritic effusion, swelling and tenderness over one hip, and secondary hemorrhage from the stump, which was cured under the tonic and stimulating plan of treatment. The quinine very decidedly checks

the rigors; but does not appear to influence the temperature or the sweats. In some cases I have administered the chlorate of potass largely (ʒij to ʒiv in the day), in addition to the quinine and wine, with apparent benefit. If the depression be very great, carbonate of ammonia in ten or fifteen grain doses may be given from time to time; such fluid nourishment as the patient will take, with a liberal allowance of wine, porter, or brandy, being also administered. In addition to this medicinal treatment, hygienic measures must be put in force. The patient should throughout, be placed in an airy and well-ventilated apartment, and cleanliness carefully attended to.

In the case of a superficial vein being inflamed, it has been recommended by Bonnet, Bérard, and Laugier, that the actual cautery should be freely applied along the course of the vessel; and they state that the best results have followed this practice. As abscesses form, these must be freely opened; and the diffuse and purulent collections forming in the areolar tissue must be evacuated; the cavities being well syringed out with antiseptic lotions.

[M. Labat, of Bordeaux, recommends *ergotine*, administered internally, as a prophylactic against pyæmia. (*Am. Journ. Med. Sciences*, Jan. 1868, p. 184.)—A.]

CHAPTER XXXIV.

TUMORS.[1]

The frequency with which *tumors* fall under the observation of the surgeon, the great variety in their characters, and their important relations, local as well as constitutional, render their consideration one of great moment. According to Hunter, a tumor is "a circumscribed substance produced by disease, and different in its nature and consistence from the surrounding parts." This definition, though not perhaps accurately correct in some forms of tumor, which do not differ in their nature from neighboring parts, is yet clinically a convenient one. By a tumor may also be said to be meant a more or less circumscribed mass, growing in some tissue or organ of the body, and dependent on a morbid excess of, or deviation from, the nutrition of the part. These growths may therefore be considered under the two heads of local hypertrophies, or outgrowths of the normal structure of the part; and of new formations, presenting structural characters which differ more or less widely from those of the parts around. The tumor thus formed increases in size by an inherent force of its own, irrespectively of the growth of the rest of the system, but still obeys the same laws of growth which govern the body generally. In order to constitute a tumor, it is necessary that the normal form of the part be widely departed from; a mere increase in its size, so long as it preserves its usual shape, being scarcely considered in this light. Thus, if the tibia be uniformly enlarged to double its natural size, the enlargement is a hypertrophy, not a tumor; but if a comparatively small rounded mass of bone project directly forwards from its tuberosity, it is said to be a tumor and not a mere hypertrophy.

Classification of Tumors.—A classification of tumors may be founded either upon their anatomical structure, or upon their vital and clinical characters; and although these two systems may occasionally lead to a somewhat similar grouping of individual growths, yet our knowledge is at present too imperfect to enable us to point out in every case the connection between clinical history and histological structure. Surgeons have long divided tumors into two great classes—the *non-malignant* and the *malignant*. This division, however, though practically convenient, is not scientifically exact. Recent researches have shown that, although some tumors, as the cancers, are always and essentially malignant, and others as uniformly benign, as lipomas and some cysts, yet many others that are usually innocent, may, under

[1] The most exhaustive treatise on this subject is Virchow's great work, *Die Krankhaften Geschwülste* (the *Pathology of Tumors*); whilst in his *Cellular Pathology* will be found an exposition of his views of the development of new formations. The reader will find in Paget's classical *Lectures on Surgical Pathology* the best account of the clinical characters of these growths.

certain conditions at present unknown, take on a truly malignant action; this has led to the establishment of an intermediate group that may be termed the *semi-malignant.*

The *non-malignant*, *innocent*, or *benign tumors* are strictly local in their development, and are rarely connected with any constitutional or hereditary peculiarity. They resemble more or less completely the normal textures of a part, and hence are very commonly, though not perhaps with strict propriety, termed *homomorphous.* They usually, though not invariably, grow slowly, are more or less distinctly circumscribed, being often inclosed in a cyst, and have no tendency to involve neighboring structures in their own growth; any change that they induce in contiguous parts not consisting in the degeneration or conversion of these into their own structures, but simply in displacement or atrophy by their size and pressure. They are sometimes single, but not unfrequently multiple, developing either simultaneously or successively; but if in the latter mode, without any connection with preceding growths. If removed by operation, they do not return; but if left to the natural processes of nature, they may slowly attain a great size, remain stationary, and at last atrophy, decay, or necrose.

The essentially *malignant tumors* differ widely from those last described. They cannot be considered as strictly local diseases, as in many cases they result primarily from a constitutional or hereditary vice, or, if local in the first instance, have a tendency rapidly to affect the constitution, and to reproduce themselves in distant parts of the body. They are usually characterized by an extreme vegetative luxuriance, and an exuberant vitality. They represent an extreme departure from the ordinary nutrition of the part, and, when once found in any organ or tissue, they develop by an inherent force of their own, irrespectively of neighboring parts, producing masses which differ entirely in structure and appearance from anything observed in the normal condition of the body, and hence are not unfrequently called *heteromorphous.* This term, however, cannot be considered strictly accurate, inasmuch as the microscopic elements of which the masses are composed have their several analogues in the normal structures of the body. But though the individual constituents of the tumor may be normal, their aggregation and mode of arrangement are totally abnormal, and differ from everything met with in a healthy state of the tissues. The mass, which may either be infiltrated in the tissues, or localized by being confined to a cyst, increases quickly in size; not uncommonly, indeed, the rapidity of the growth may be taken as a measure of the malignancy of the tumor. As it increases in size it tends to implicate the neighboring structures in its own growth, and to affect distant organs through the medium of the lymphatics or the blood; if removed by operation it has a great tendency, under certain conditions, local and constitutional, to return in its original site or elsewhere, though it does not necessarily do so. If left to its own development, a malignant tumor will inevitably soften, necrose, and ulcerate, often with much pain, profuse hemorrhage, and the induction of a peculiar state of constitutional cachexy, which speedily and necessarily terminates in death.

The following may be looked upon as the principal signs of malignancy in those tumors—as cancers, which are anatomically as well as pathologically malignant—in which, in fact, the structure taken as a whole differs from anything that normally exists in the body, and in which the progress of the disease has an invariable tendency to proceed from a primarily local to a secondarily constitutional condition.

1. The tumor, whether arising spontaneously or as the result of external violence, whether occurring in an individual in whom there has previously existed an hereditary tendency to similar or to allied disease, or in one whose progenitors have never evinced any tendency to similar affections, is invariably at first small, and is usually circumscribed with a distinct outline.

2. There is a constant tendency to the extension of the disease by local infiltration into and the absorption of neighboring structures; not only by their mere absorption by the pressure of an increasing growth, but by their actual incorporation into its very substance, and the deposit of the morbid mass in their place.

3. This process continues uninterruptedly; in many cases very slowly, as in scirrhus of the breast; in others, in special forms of disease, and in certain situations, as in encephaloid of the bones, of the eye, or of the testes, very rapidly.

4. The rapidity of the growth of the tumor, and of the absorption and incorpora-

tion of the neighboring structures, is usually in the measure of and in proportion to the malignancy of the affection.

5. The course of the tumor is always a definite one until it attains the maximum of its development. When once this culminating point is reached it undergoes a process of softening, of disintegration, and of sloughing, with considerable discharge, usually of an offensive character, and not unfrequently with abundant hemorrhage.

6. At a certain period of the growth—early in some cases, not until many months have elapsed in others—the lymphatics and the absorbent glands immediately above the primary disease, those intervening between it and the central portions of the system, become enlarged and hardened in consequence of the deposit within them of morbid material identical in character with that which constitutes the primary or original disease. This secondary implication of the lymphatic glands is undoubtedly due to direct absorption. It may occur before the skin is involved; but invariably manifests itself when once the integumental structures are implicated in and infiltrated by the malignant disease. The disease has a tendency to run the same course in the glands that are thus secondarily affected as it does in its primary seat.

7. At a later period than this the internal organs, more especially the lungs and liver, become the seat of secondary deposits of a similar nature essentially, though differing possibly in some minor characters, to those which were primarily developed in the original seat of the local affection. These secondary visceral deposits occasionally become the foci of new development of the disease, which assume a more fatal character than the primary affection to which they owe their origin.

8. After the contamination of the lymphatic glands, the constitution of the patient exhibits evidences of serious modifications in nutrition and sanguification. The body wastes, the skin becomes sallow, the digestive powers become impaired, and anæmia supervenes.

9. Death may occur in various ways: from the exhaustive effects of the discharges, and hemorrhages from the local and primary disease; from special visceral disturbance induced by the secondary deposits, or from malnutrition and consequent cachexy.

The malignant tumors are usually of a cancerous nature, but "*malignant*" and "*cancerous*" are not synonymous terms. Every malignant tumor is not a cancer, though every cancer is a malignant growth. Some tumors occasionally present the clinical characters of malignancy, though structurally they are intimately connected with others which are usually looked upon as essentially non malignant; and we are thus obliged to consider, that these terms are merely relative, and that these two great classes pass into one another by insensible gradations. It will be subsequently seen that the fibroid, fibro-plastic, and cartilaginous tumors stand in this intermediate position between the more typical examples of these two great groups. Those benign tumors which have a tendency to recur after removal, and thus to run as it were a locally malignant course, are usually very rapid in their growth and development. Indeed, great rapidity of growth may usually be looked upon as either an evidence of malignancy of structure or of liability to speedy recurrence after extirpation. These rapidly growing and recurrent tumors, simple in structure but malignant in course, are chiefly met with in the bones and testicle as enchondromata, in the breast as adenomata and fibroid tumors. In some cases, after repeated removals, the tendency to recurrence appears to wear out, and the patient eventually overcomes the disease. But in other instances this fortunate result does not occur. Where tumors of any kind recur after removal, it will be found that the secondary differs in many important respects from the primary growth. Thus it will be found to be softer, semi-diffluent, often more vascular and more diffused. In microscopical structure it will be found to present evidences of more activity of growth, departing more widely from normal and approximating more closely to malignancy of type. Paget has very fully described varieties of the fibro-plastic as well as of the fibrous and cartilaginous tumor, which, though preserving throughout an uniform character, microscopical and otherwise, which is not considered malignant, have nevertheless destroyed the patient by repeated recurrence after removal, and by ultimate ulceration, sloughing, and contamination of neighboring tissues, or even of distant organs through the medium of the circulation. He makes the important observation that, in different persons and under different conditions, the same disease may pursue very opposite courses, appearing in some to be of an

innocent, in others of a malignant type; and he makes the very interesting practical remark, which agrees entirely with the result of my own observation, that the children of cancerous parents may be the subject of tumors apparently innocent in structure, but certainly resembling malignant growths in the rapidity of their progress, their liability to ulcerate and to bleed, and their great disposition to return after removal.

The term *semi-malignant* may be employed to include those growths which occupy the doubtful position indicated above: it must, however, be distinctly understood that these terms cannot be employed in any very definite sense.

Innocent and malignant tumors are occasionally met with in the same person, four or five different kinds of growth even occurring in one individual. I have seen in one patient a scirrhous breast, an enchondromatous tumor of the leg, and atheromatous cyst on the back, with scrofulous glands in the neck. New formations of different types may even be found in the same mass; thus, encephaloid and enchondroma are not unfrequently met with together in the testis. This, however, must not be taken as any evidence of the possibility of the conversion of one into the other, but rather as the result of a departure in different directions from the normal nutrition of the part. There is indeed no proof that a non-malignant can be converted under any circumstances into a malignant tumor of a different type; a fibrous growth may degenerate and assume all the character of malignancy, at last destroying the patient, but there is no evidence that it can ever be changed into a cancerous mass. A malignant tumor may, however, appear on the site of a non-malignant growth that has been removed: thus I have seen a scirrhous nodule deposited in the cicatrix left after the removal of a cystic sarcoma of the breast.

Besides these various forms of tumors, others are met with, of a constitutional and specific character, such as those that occur in connection with scrofula and syphilis.

The following classification will be found to be clinically useful, although it can hardly be considered as anatomically correct:—

I. Non-malignant and semi-malignant tumors.
   1. Cystic tumors of all kinds.
   2. Tumors dependent on the simple increase of size of already existing structures in the tissues or organs in which they occur; as, for instance, fatty tumors in adipose tissues, exostosis in connection with bone, adenoid tumors in the breast, &c.
   3. Tumors dependent on the new growth of already existing structures in situations where they are not normally found; as, for instance, a cartilaginous tumor in the midst of areolar tissue, or an osseous tumor in a gland. It is in this class that the semi-malignant growths are found.

II. Malignant tumors.
   1. Encephaloid; representing the more acute form.
   2. Scirrhus; representing the more chronic form.
   3. Epithelial cancer.

The other varieties of cancer usually enumerated, are melanotic or black cancer, and colloid or glue cancer; of these the former is probably merely a variety of encephaloid, and the latter is probably not a true cancer at all.

A classification founded upon an anatomical basis not only enables the observer to comprehend the precise relation which any particular growth under observation bears to others that resemble it; but it leads him to trace the origin of the new formation from the pre-existing structures of the part in which it occurs, thus forming the first step towards a knowledge of the ætiology of the disease. Tumors are said to be heterologous or homologous, according as they present a greater or less deviation from the normal condition of the tissues from which they spring. These terms are essentially relative; and it is only to individuals at the extreme ends of the series that either term can be definitely applied. The more heterologous the growth, that is, the greater the departure from the normal nutrition of the part in which it occurs, the more malignant, as a rule, will be its action upon the system generally; whilst the reverse, with similar exceptions, is true of homologous formations. At the same time it must be borne in mind, that Virchow's law holds good even in the most heterologous departures from the standard of health; this law states, that "the same types of anatomical structure exist in new formations as are

found in the body generally," and thereby denies the possibility of the occurrence of a true heteroplasia, and the existence of specific elements in new formations.

The following classification may be adopted as possessing the same clinical convenience as that given above, at the same time that it presents the additional advantage of anatomical uniformity:—

I. Cystic tumors generally.

II. Tumors produced by local hyperplasia of complex structures, as, for instance, papillary and glandular formations.

III. Tumors possessing a structure belonging to the connective tissue type; the fibroid, the cartilaginous, and the osseous.

IV. Tumors possessing a structure belonging to the epithelial type; the cancers, encephaloid, scirrhous, and epithelial.

V. Tumors derived from the lymphatic tissue type; typhoid and tubercle. The latter only comes within the province of the surgeon.

Before proceeding to consider the individual growths, which are thus grouped together, it will be desirable to describe briefly the essential features presented by the structures, upon the type of which the third and fourth classes are founded.

The elements of the connective or areolar tissue exist throughout the body, presenting however many varieties of form adapted to the special functions of each particular part in which it appears. It consists essentially of an intercellular substance, hyaline or fibrillated, in which are imbedded cells having an oval, caudate, fusiform or branched form, and usually presenting a distinct nucleus or nucleolus. The connective tissue cell is now generally looked upon as a modification and derivative of the lymph or white blood-corpuscle, and probably gives origin under pathological stimuli to the inflammatory lymph pus-corpuscle. It usually presents itself as an oval or fusiform cell measuring about $\frac{1}{1500}$th to $\frac{1}{2000}$th inch in diameter, with a nucleus and nucleolus, which are rendered distinct by the addition of water or acetic acid. This corpuscle is looked upon by the cellular pathologists as the starting point from which are derived the various cell-structures, which constitute so large a proportion of the products of abnormal nutrition.

The following tissues may be considered as belonging to this type, the pathological deviations from which must be viewed in the same light;—the connective or areolar, the white fibrous, and the yellow elastic tissues in all parts of the body, whether entering into the formation of organs, or existing as separate structures; the cartilaginous and osseous tissues represent two important modifications, but exhibit occasionally a tendency to return to the primary form as described above. The essential character of the epithelial type is, that it presents a simple cell-structure without any intercellular substance. The cells are in all probability derived from the same source as the connective tissue corpuscle. As a normal element, epithelium can only exist on free surfaces, and it is to be found on all the membranes lining the cavities of the body. When developed in any other position than this, it constitutes the greatest departure from healthy structure which may be met with. The cells of epithelium present a very great variety in their form and size, and, though usually possessing but one nucleus, may sometimes contain several nuclei, as in the transitional epithelium from the bladder.

The characters presented by the several groups of tumors will now be considered.

I.—CYSTIC TUMORS.

Cystic tumors may be classified according to their contents, or according to their anatomical characters and mode of development. The following is an example of the former method:—

1. *Dermoid cysts*, presenting three varieties—
   - *a.* Those containing epidermis.
   - *b.* Those containing true skin, hair, and glands.
   - *c.* Those containing cartilage, bone and teeth.
2. *Serous cysts*, arising in four different ways—
   - *a.* By dilatation of sacs, cavities or canals, including bloodvessels.
   - *b.* By accumulation of fluid in the meshes of areolar tissue.
   - *c.* By changes in hemorrhagic effusions.
   - *d.* By changes in the products of inflammation.

3. *Colloid cysts*, resulting from—
   a. Colloid degeneration of pre-existing cells.
   b. Colloid degeneration of newly-formed cells.

The second method will, however, be adopted here as being the more simple and more clinically useful. Cystic tumors are divided into two great classes:—

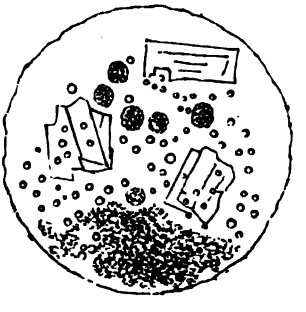
1. Those that are dependent upon the gradual accumulation of a secretion in a naturally existing duct or cyst, with dilatation and hypertrophy of its walls.

2. Those that result from the new formation of a closed cyst in the areolar tissue of the part, and the distension of it by the secretion from its lining membrane.

1. *Encysted tumors, arising from simple distension and gradual hypertrophy of the walls of a duct or cyst*, are met with in three forms: (*a*) Encysted tumors of the skin and subjacent areolar tissue occurring in various parts of the body, and dependent on the closure of the excretory ducts of the sebaceous glands; (*b*) Tumors formed by the accumulations of secretions in, and the closure and dilatation of, the ducts of other secreting glands and organs, as in the sublingual or the mammary glands; (*c*) Those formed by the retention and modification of the secretions in cysts without excretory ducts, as in the bursæ.

(*a*) *Encysted tumors, produced by the obstruction of the excretory ducts of the sebaceous glands*, include the various forms of *atheromatous tumors* that are met with on the surface of the body. These are usually situated upon the scalp, face, neck, or back; sometimes, however, they occur elsewhere—thus I have removed a very large one from the fore part of a girl's arm, and others from the labia and groin. The size of these tumors varies from that of a pin's head to an orange; the smallest occur on the eyelids, the largest on the shoulder and scalp. They are often very numerous, especially about the head, where as many as thirty or forty may be met with at the same time; and most frequently they form in women about the middle period of life: they are smooth, round, or oval, movable under the integument, either semi-fluctuating or elastic, though sometimes solid to the touch. In some parts where the sebaceous follicles are large, as on the back, a small black point can often be detected on the surface of the tumor, through which an aperture may be found leading into its interior, and allowing the expulsion of its contents. A sebaceous tumor is composed of a cyst which varies greatly in thickness, being sometimes thin, filamentous, and soft; in other cases, so thick, hard, laminated, and elastic, that it is almost impossible not to believe it to be a new formation. These cysts attain their greatest density on the scalp, and are here often very firm, elastic, and resisting, even though of but small size. In structure they consist of cellulo-fibrous tissue, with an epithelial lining, and generally appear to be dilated and hypertrophied sebaceous follicles; though not improbably, as Paget supposes, they may at times be new formations. They are usually attached by loose areolar tissue to the subjacent parts; but, if thin, they are often rather closely incorporated with the super-imposed skin. If inflammation be set up around them, they become more solidly fixed; but, if the inflammation go on to suppuration, they may loosen and so be enucleated. The contents of these cysts are very various, most usually consisting of a soft, creamy, pultaceous, or cheesy-looking mass, of yellowish-white color, which has sometimes in old cysts become dry and laminated, looking not unlike parmesan. In some cysts of old standing and large size, the contents may be semi-fluid, the more liquid parts being of a brown, green or blackish tint. These various contents are essentially composed of sebaceous secretion, mixed in various proportions with epithelial scales, fat-granules, cholesterine, granular matter, and rudimentary hairs (Fig. 185).

Fig. 185.



Contents of sebaceous tumor: cholesterine, fatty and granular matters.

Progress.—The growth of these tumors is often very slow; but not unfrequently, after remaining stationary for years, they take on a rather rapid increase. The tumor itself, though painless, may give rise to uneasy sensations, by compressing nerves in its vicinity; it usually continues to grow slowly, until, the patient, being annoyed by its presence, has it removed by operation. If left untouched, it occasionally, though rarely, happens that the sebaceous matter, exuding through

Fig. 186.

Horn on nose of a child.

an aperture on its surface, forms a kind of scab or crust, which by a process of subdeposition becomes conical; and, being gradually pushed up from below, at the same time that it assumes by exposure a dark brown color, forms an excrescence that looks like a horn, and is usually considered to be of that character (Fig. 186). These "horns" have been met with on the head, on the buttock, and in other situations. The accompanying drawing is taken from a child four years old, brought to me to have its horn removed; a woman also once applied to me with one about an inch and a half long, growing from the upper lip.

In other cases, these tumors inflame and suppurate; the skin covering them becomes adherent and reddened, ulceration takes place, and, if the cyst be small and dense, it may be thrown off by the suppurative action in the surrounding tissues. If it be of larger size, ulceration of the integuments covering it takes place, and the sebaceous matter is exposed; this may then putrefy, become offensive, and break away in unhealthy suppuration. In other cases, again, peculiar changes take place in this tissue: large granulations are thrown out in it, and the atheromatous mass appears to vascularize, becoming irregular and nodulated, rising up in tuberous growths with everted edges, exuding a fetid, foul discharge, becoming adherent to subjacent parts, and assuming a semi-malignant appearance, forming at last a sore perhaps as large as a saucer, as in the annexed figure of a case sent to me by Dr. Bryant (Fig. 187). Sebaceous cysts which have undergone this change may, however, readily be distinguished from malignant growths by a microscopical examination of their exudations or *débris;* these consisting of pus and healthy epithelium, mixed up with fatty matters more or less disintegrated.

Fig. 187.

Ulcerated encysted tumor of scalp.

Diagnosis.—The only diseases with which these tumors can be confounded are abscesses and fatty growths. From an *abscess* an encysted sebaceous tumor may be distinguished by its history, slow growth, situation, elasticity, and mobility, and the existence of the dilated orifice of the sebaceous duct, through which some of the contents can be squeezed, the microscopical examination of which will serve to confirm the diagnosis. From *fatty tumors* these growths may be diagnosed by their firmer and more regular feel; and in case of doubt by the evacuation and examination of their contents.

The *treatment* of a tumor of this kind simply consists in its removal, after which it is never reproduced. So long as these tumors are small, and do not give rise to deformity or inconvenience, they may be left without surgical interference. But when large, and more particularly when they have become inflamed they should be removed. The method of operation will vary according to their situation and the thickness of their walls. When situated on the scalp, where the cyst is dense and tough, the tumor may very readily be removed by transfixing the upper part of it and the skin covering it with a scalpel, squeezing out the atheroma, and then seizing the edge or bottom of the cyst with forceps and pulling it out. In this little operation there are two points that require attention: first, the base of the cyst should never be transfixed; and, secondly, no attempt at dissection should be made: if either of these cautions be neglected, troublesome hemorrhage may ensue. No dressing is required after the operation beyond a piece of dry cotton wool, which may be laid on the wound. This will generally heal by the first intention. Should it not do so, water-dressing should be applied. When they occur upon the scalp, a large number of these tumors may be removed at one sitting; as, however, there is always some danger of erysipelas following operations in this situation, it is only prudent to select a favorable season of the year, and not to operate if the health be out of order. Erysipelas is the only danger to be apprehended; it is especially apt to occur in elderly people of a stout make and florid complexion. When seated

about the back, trunk, or limbs, they usually require to be dissected out, being thin and more closely incorporated with the skin, and often, in consequence of former inflammation, adherent to the subjacent parts. In doing this, care should be taken that the whole of the cyst is extirpated; the wound should be dressed lightly, and speedily heals. If, however, any portion of the cyst be left, it should be freely rubbed with nitrate of silver, lest a troublesome fistula remain. When the tumors are situated between the shoulders or on the back, and the patient is unwilling to submit to an operation, I have sometimes easily and successfully removed them by opening up with a probe the small black orifice, which will always be found leading into them, squeezing out the contents of the cyst, and then pushing in two or three silk threads, which, acting like a seton, have excited the requisite amount of inflammatory action to bring about a closure of the cyst.

There is one situation in which these cysts are often met with, and where their removal requires special care—viz., at the outer angle of the orbit in children; here they are apt to develop shortly after birth, and are excessively thin-walled, requiring careful dissection to extirpate the whole of the cyst.

The horns and semi-malignant ulcers that result from these growths, may require excision. If, however, the ulceration be connected with the cranium by its base, or be very extensive, as in the case depicted (Fig. 187), it will be safer to treat it by the application of a weak solution of the chloride of zinc, or by occasionally touching it with fused potass.

(*b*) Various forms of encysted tumor may arise from the *closure and dilatation of the ducts of other excretory organs;* as, for instance, *ranula* from the occlusion of the salivary ducts, *encysted hydrocele* from the closure of the tubuli testis, or *cystic tumors of the breast* from the obstruction of the lacteal ducts. These affections, however, constitute special diseases, the consideration of which must be deferred to subsequent chapters. The general principle of *treatment* in these kinds of affection, consists either in restoring the freedom of the outlet by the excision of a portion of the wall, or obliterating the cyst by making an incision into it, and allowing it to granulate from the bottom.

(*c*) Cysts may arise from the *distension of cavities which are unprovided with any excretory duct;* as, for instance, the bursæ; which often attain a very considerable size under these circumstances. The structure of these cysts becomes greatly altered; sometimes the walls are thin and expanded; at others they acquire a thick cellulo-fibrous, almost ligamentous, appearance. Inside they are often warty-looking, from the deposition of imperfectly organized fibrine, often arranged in a laminated form. Not unfrequently attached to the walls, and floating in the interior, are a number of granular, melon-seed-like bodies, grayish or yellow in color, semi-transparent, elongated or irregular in shape, usually rather hard, but at others soft and flocculent. These appear to be composed of masses of imperfectly organized fibrine, somewhat resembling in structure granulation-cells, and often form in large quantities, so as to block up the interior of the cyst, converting it into a solid tumor. The fluid contents of these cysts are usually thin and serous, of a yellowish or brownish color. In their progress these cysts are found to increase up to a certain size, when they usually thicken and harden, in consequence of the fibrinous transformation just described; or else they inflame and suppurate in an unhealthy manner. They may occur in any of the situations in which bursæ naturally exist or are accidentally formed, and which will be mentioned hereafter, but are most commonly met with upon the knee-cap, the nates, or the first joint of the great toe.

The simple forms of *cystic tumors of the ovary* may be placed under this head, as they arise from a dilatation of the Graafian vesicle, and are filled with a more or less clear serous fluid. They sometimes attain an enormous magnitude.

The *treatment* of the cysts derived from bursæ consists in attempting their absorption by the use of stimulating plasters; or, if this fail, in the removal of their contents by tapping. Their cavities are then closed by exciting inflammation and suppuration within them, by the introduction of a seton, by injection with stimulating solutions, or by the subcutaneous section. If these means fail, excision will be required, more especially if the tumor have assumed a dense and fibrous character.

2. *Cysts* occasionally are met with as *new formations*, filling by their own secretion. They occur in the general areolar tissue, and in connection with the sheaths of tendons; but most frequently about the generative organs, more especially in the ovary, in the broad ligament of the uterus, or in the breast. These cysts vary most widely

in size, from that of a millet-seed to tumors weighing many pounds, and filling up the greater part of the abdominal cavity. When small, they are usually thin-walled, and are often imbedded in a matrix composed of imperfect hypertrophy of the organ in which they are situated, as in the breast and testes; when large, as in the ovary, the walls are thick, firm, satiny, and often very tough. Projecting into their interior are solid masses, consisting of cauliflower-like growths, occasionally filling up the whole inside of the cyst with compact solid white layers. These "intracystic" growths cause by their increase in size the gradual absorption of the more fluid contents, until, at last, their development is arrested by the cyst-wall.

These cysts may be divided into the *simple* and the *compound*. The *simple*, or, as they are commonly called, *serous cysts*, are met with in almost every situation, being composed of a thin expanded wall, containing a slightly viscid serous fluid.

The *compound*, or, as they are often called, *proliferous* or *multilocular cysts*, are especially met with in the ovary, and have been studied with great care by Hodgkin, and more recently by Wilson Fox. Of these there are two varieties, the first consisting of an aggregation of simple cysts closely packed and pressed together; the second composed of cysts having others growing from their walls. The cavities of these multilocular cysts present the greatest possible variety in their contents; fluid, from a limpid serum to a semi-solid jelly-like matter, and of every shade, from light-yellow to greenish black, or dark-brown, is met with in them: solid intracystic growths, cancerous masses, or the *débris* of epithelial and cutaneous structures, are also found in them.

Wilson Fox has shown that these secondary cysts are the results of constrictions of portions of the ducts of glandular structures, associated with the hypertrophy and fresh growth of tubular formations; a view which satisfactorily explains the occurrence of epithelium and other adenoid structures within them. Some of the secondary cysts associated with the papillary growths appear to result from the cohesion of adjoining masses of papillary structure, and thus present cavities lined with epithelium, similar to that which lines the parent cyst and the papillary mass itself. The intracystic growths themselves appear to be derived from the superficial strata of the stroma of the cyst-wall, and, as they arise by protrusion into the cavity of the cyst, they are necessarily covered by the same epithelium which lines the latter.

Villous growths are also found scattered in patches on the inner surface of the cyst-wall. They are always highly vascular, consisting almost entirely of loops of vessels covered by a layer of epithelium. These are intimately connected with the development of gland-structures.

The *sanguineous cyst*, or *hematoma*, is a peculiar variety of the simple form, and has been described by Paget as principally occurring about the neck, the parotid, the anterior part of the thigh, the leg, the shoulder, and the pubes. It is especially characterized by containing fluid blood, more or less altered in appearance. He describes these cysts as being formed in three possible ways; either by hemorrhage into a previously existing serous cyst, by transformation from a nævus, or by a vein becoming occluded and dilating into a cyst. I have seen a large hematoma on each ear of a lunatic. The contents were semi-solid coagulum. These sanguineous cysts may sometimes resemble in general appearance encephaloid disease. A case of this kind was sent to me by my friend, Dr. Henry Bennet—a tumor of about the size of an orange, of nodulated appearance, existing in the leg of a woman below the knee, where it had been gradually increasing in size for about a couple of years. So close was the resemblance to malignant disease presented by the tumor, that the limb had been condemned for amputation by some surgeons who had previously seen the case; as, however, the growth, on examination, proved to be a sanguineous cyst, as its walls were thin and adherent, and as it extended too deeply into the ham to admit of ready removal, I reduced it by successive tappings, and then, laying it open, allowed it to granulate from the bottom. When practicable, however, the cyst should always be dissected out.

Encysted tumors containing hair and fatty matters (*pilo-cystic tumors*, or *dermoid cysts*), are occasionally met with. These would, in many instances, appear to be the remains of blighted ova inclosed in the body, as they are congenital, and usually contain some fœtal *débris*, such as portions of bone, teeth, &c. The hairs in these tumors are connected with, and grow from, cuticular structures in which sebaceous follicles are commonly distinctly observable. The fatty matter which they contain

in large quantity, and which may either be solid or perfectly fluid, is in all probability the result of fatty degeneration of the soft tissues of which they are composed. These tumors are most frequently met with in the abdomen, especially about the ovaries, mesentery, and omentum: they have also been observed in connection with the testis, having probably descended into the scrotum with this gland. A very remarkable case of this kind once occurred at University College Hospital under Mr. Marshall. They have also been found about the face, within the skull, and in the lung, but never, I believe, in connection with the extremities.

Cysts containing fatty matters present several varieties. The contents may be derived from the fatty degeneration of epithelial structures, or of the contents of a cyst originating in any of the ways above described. Sometimes the fatty matters are in the form of a half-fluid, oily emulsion, or of a white cheesy mass of the consistence of soft putty; at others, they present a very peculiar appearance known as *cholesteatoma* (*perlgeschwulst*, *tumeur perlée*). This consists of a smooth, laminated, white and dry fatty mass, contained in a cyst, and composed partly of concentrically arranged epithelial cells, and partly of crystalline fat and cholesterine. Virchow has described this as a distinct variety of tumor, and considers that it is not necessarily connected with epithelial formations. It usually occurs in the temporal bone, but has been found in the cerebellum. It is a very rare form of tumor.

II.—TUMORS PRODUCED BY LOCAL HYPERPLASIA OF COMPLEX STRUCTURES.

These tumors differ from simple hypertrophies in this, that there is always some departure from the normal type of form in the part affected, and that, although the individual elements remain the same, the proportion existing between them is usually modified.

This section comprises: 1. Tumors connected with the integumental structures, as papillary and warty growths, and simple polypi; 2. Lobular hypertrophy with more or less modification of glandular structures—(*a*) in the skin and mucous membrane, (*b*) in the breast, testis, &c.; 3. Vascular tumors; 4. Tumors of nerves; 5. Tumors of muscle.

1. *Tumors connected with the Integumental Structures, whether Mucous or Cutaneous.*—The simplest of these formations are *corns*, which consist merely of an undue development of cuticle, with a slight increase in the vascularity of the subjacent cutis; subsequently the papillæ themselves become enlarged, especially when the irritation has been prolonged or considerable.

Warts are the result of a primary hypertrophy of the papillæ, accompanied by the formation of new vessels, and leading to a great increase in the development of the epidermis, which forms horny laminated strata, and sometimes produces masses with a concentric arrangement of the cells, closely resembling the nest-like structures seen in epithelioma. The true warts are most commonly found on the skin, and are then often very hard and horny. Softer varieties are, however, found on the muco-cutaneous surfaces, especially of the prepuce and vulva, and are usually of a specific origin; they often present a mixed character, and tend to pass insensibly into the next group. Warts may be the result of a local irritation, but in many cases they appear to depend as much upon some constitutional condition.

Condylomata and mucous tubercles present a still greater departure from the normal condition of the part, and are considered by some as belonging to a different class of formations, the sarcomata. The papillæ are not simply hypertrophied, but present some modifications in their anatomical structure, the fibrous tissue of the corium being softer, and containing a greater proportion of cells and nuclei. It is, however, convenient to retain them under the present head, because we find a very gradual transition from the true wart to the most truly sarcomatous papilloma, as these formations are often termed. They occur on the mucous or muco-cutaneous surfaces, and have usually a specific origin. When situated on the mucous membranes, they are often pointed, somewhat pendulous or nodulated on the surface, very vascular, and bleed readily when touched; but when they occur on a muco-cutaneous surface, they are flattened, expanded, soft, and white, constituting the true condylomata or mucous tubercles.

Allied in structure to these latter growths, though probably truly belonging to

the next class, is a peculiar pinkish white fibro-vascular tissue, which is occasionally met with in old cicatrices, more especially after burns, as an outgrowth of these, and not unfrequently recurs after removal; this disease is termed *Cheloid* (see p. 168).

The general principles of *treatment* of these affections consist in their removal by excision, ligature, or caustics, according to their size, situation and attachments. Excision is usually preferable when they are seated on mucous surfaces; the ligature should be used if they be large and pendulous; and caustics should be employed when they are seated on the skin or a muco-cutaneous surface.

Polypi are pendulous masses growing from any mucous surface, but more especially from the nose, ear, throat, uterus, and rectum. The term polypus is applied very indiscriminately to various pendulous tumors growing from mucous membranes some of which belong to the present class, whilst others belong to the sarcomata. The true *mucous* or *gelatinous* polypus is composed of the elements of mucous membrane expanded and spread out, and consists of a loose fibrous stroma covered by epithelium more or less distinctly ciliated, the cilia being often beautifully seen when recent specimens are examined under the microscope. The so-called *fibrous* or *medullary* polypus consists of other forms of tumor growing from, and covered by, mucous membrane. The true mucous polypus grows rapidly, being a soft and vascular reddish-purple or brown-looking mass, and may expand greatly, giving rise to serious symptoms of obstruction in the passage in which it is situate, bleeding freely when touched, destroying the bones by its pressure, and producing great mischief and disfigurement. It is especially in the nose and the uterus that it attains to a large and dangerous size. The *treatment* consists in removing it according to its situation, its degree of vascularity, and the nature of its attachment, by avulsion, ligature, or excision.

2. *Hypertrophy of Glandular Structures.*—This forms an important series of special affections, occurring (*a*) in the small glands of the skin and mucous membrane, or (*b*) in the larger glands which constitute individual organs.

The part becomes chronically enlarged and indurated, usually without any signs of inflammatory action, though in some cases apparently as the result of this condition. On examination, the structure of the gland or lobule affected will either be found to have undergone an imperfect or ill-developed hypertrophy in some of its lobules, or to be expanded by the accumulation of glandular epithelium, which will be found in many cases to have undergone degeneration, and to have given rise to cheesy masses, which may be mistaken for tuberculous deposits.

In the skin and mucous membrane these formations are usually accompanied by an increased growth of the papillæ, and are often mistaken for epithelioma; this error is the more likely to arise, as it is not uncommon to find very well-marked nests of flattened epithelial cells produced in the distended extremities of the gland-ducts. I have removed such a growth from the lip under the impression that it was truly epitheliomatous in character; but it proved, on careful microscopic examination, to be of a glandular origin. Though purely local in their origin, these tumors often produce troublesome ulceration, and may even return in the adjacent parts after removal by the knife; they probably never give rise to secondary formations in other organs.

Glandular tumors in such organs as the breast, testis, &c., usually appear as distinctly circumscribed masses affecting one or more lobules. The special features, however, presented by these growths will be considered when we come to the diseases of the organs themselves.

The *treatment* of these tumors consists in an endeavor to remove the mass by friction with the preparations of iodine, or by the application of stimulating and absorbent plasters. If these means fail, methodical pressure may sometimes advantageously be employed; and, as a last resource, extirpation by the knife must be performed.

Tumors dependent on an increase of (3) the *vascular tissue*, as aneurism by anastomosis; of (4) the *nervous tissue*, as some kinds of neuroma; and of (5) *muscular tissue*, if these really exist, may be more conveniently studied in the chapters devoted to the consideration of the structures to which they belong; and it will be sufficient for the present to indicate their existence in connection with this group. Some tumors composed of *osseous tissue*, as simple exostosis, really belong to

this group, but have been placed in the next class to indicate their other more important affinities.

III.—TUMORS OF THE CONNECTIVE TISSUE TYPE.

This class constitutes the largest and possibly the most important group of new formations with which the surgeon has to deal, and contains individuals which differ most widely in their clinical characters, but which are nevertheless closely united by structural and developmental affinities. The type upon which this class is founded has been explained above, and in considering the growths derived from it we shall pass from the most homologous to the most heterologous.

1. Those derived directly from connective tissue: (*a*) fatty tumors, lipoma; (*b*) fibroid tumors (simple); (*c*) the sarcomata, consisting of areolar, fibro-cellular, myxomatous, and recurrent fibroid tumors; (*d*) fibro-plastic and myeloid tumors; (*e*) granulation tumors.

2. Those derived from or formed upon the type of cartilage: enchondroma.

3. Those derived from or formed upon the type of bone: (*a*) exostosis; (*b*) osteosarcoma; (*c*) malignant osteoid.

1. **Tumors derived directly from Connective Tissue.**—*a. Fatty tumors* constitute an important class of surgical diseases, as they occur very extensively in almost every part of the body, and at all ages, though they are most commonly met with about the earlier periods of middle life. In the majority of cases they appear to originate without any evident cause; in other instances again they can be distinctly traced to pressure or to some local irritation, as to that of braces or shoulder-straps over the back and shoulders. In one case I have known the disease to be hereditarily transmitted to the members of three generations of a family.

Fatty accumulations take place under two forms, one diffused, the other circumscribed; it is the latter variety only that is termed the *adipose tumor*. The diffused form of fatty deposition occurs in masses about the chin or nates without constituting a disease, though it may occasion much disfigurement.

Fatty or adipose tumors may form in all parts of the body as soft, indolent, inelastic, and doughy swellings, growing but very slowly; being either oval or round, but not unfrequently lobulated, and occurring most frequently in the subcutaneous fat about the neck and shoulders, but occasionally met with between the muscles, in the neighborhood of joints, of serous membranes, as of the pleura, and of mucous canals, sometimes in very unusual situations where such growths would scarcely be looked for. Thus I removed some time since a lipoma three inches in length, and as thick as the thumb, from under the annular ligament and the palmar fascia of a young woman, where it lay in close contact with the ulnar artery and nerve. A very curious circumstance connected with these tumors is that they occasionally shift their seat, slowly gliding for some distance from the original spot on which they grew; thus, Paget relates cases in which fatty tumors shifted their position from the groin to the perineum or the thigh. I have known one to descend from the shoulder to the breast.

They may attain a large size, but only occasion inconvenience by their pressure or bulk; sometimes they appear in great numbers, upwards of 250 tumors of various sizes having been found in the same individual. They rarely ulcerate or inflame, nor do they undergo any ulterior changes of structure.

The typical *lipoma* is a mass of yellow oily fatty matter and areolar tissue, inclosed in a fine thin capsule having small vessels ramifying over its surface. This tumor is usually more or less lobulated, often remarkably dentated, and sending out irregular prolongations that extend to some little distance into the surrounding cellulo-adipose tissue.

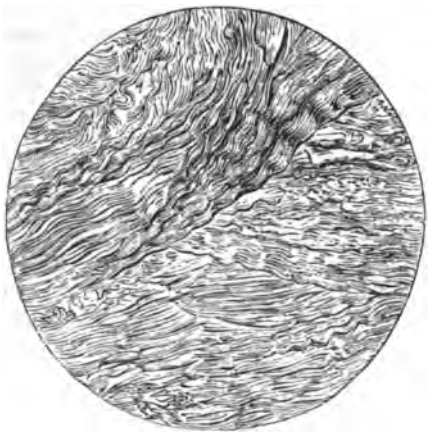
These tumors, which present the least deviation from the normal structure, are derived from the ordinary connective tissue by an increased development of oily matter in the cells of the part. They present certain minor varieties in their structure, dependent upon the proportion of the true fatty to the fibrous elements. Their microscopic characters are those of ordinary adipose tissue, but it is not uncommon to find crystalline deposits of the fatty acids in the cells.

In the *treatment* of fatty tumors, little can be done except by extirpation with the knife, by which the patient is speedily and effectually rid of the disease. The tumor,

being encapsuled and but loosely adherent to adjacent parts, readily turns out, and the wound often heals by the first intention. It is true that we have the sanction of Sir B. Brodie's high authority for the administration of the liquor potassæ in some cases, under which treatment this eminent surgeon states that fatty tumors have occasionally disappeared.

b. Fibroid Tumors.—These growths are by no means so common as many of the affections that have already been described; they are met with in various situations, as in the testes and mamma, uterus and antrum, about joints, in the periosteum, in the subcutaneous areolar tissue, and in connection with nerves. The situations in which they are most frequent, and where their structure is most typical, is in the neck, especially in the parotid region, in the uterus and the antrum. In shape these tumors are irregularly oval or rounded; they are smooth, painless, and movable; they grow slowly, but may attain an enormous size, equal to that of a cocoa-nut or water-melon. Liston removed from the neck one, which is at present in the Museum of the College of Surgeons, that weighed twelve pounds; they have, however, been found weighing as much as seventy pounds. They are almost invariably single, and when cut into present a white glistening fibrous structure, being composed of nucleated fibres like those of ligamentous tissue (Fig. 188). The cells are few in number, elongated, branched, and anastomosing. These tumors may remain stationary for years, and this is the condition in which they are often presented to the surgeon. Eventually, however, they are apt to undergo disintegration, becoming infiltrated, œdematous, and softening in the centre, or at various points of the circumference; they then break down into a semi-fluid mass, the integuments covering them inflame and slough, and an unhealthy pus, mixed with disorganized portions of the tumor, is poured out, leaving a large and unhealthy sloughy chasm, from which fungous sprouts may shoot up, readily bleeding on the slightest touch, and giving the part a malignant appearance; the patient eventually falling into a cachectic condition, and becoming exhausted by the hemorrhage and discharges. In other cases these tumors may degenerate into a spongy calcareous mass of a brownish color and hard consistence; but they never undergo proper ossification. More rarely the interior of these growths softens and undergoes absorption, so as occasionally to form cysts of large size, containing fluids of various shades of color. Paget relates the case of a very large cyst of this kind formed by the hollowing out of a fibroid tumor of the uterus, which was twice tapped by mistake for ovarian dropsy.

Fig. 188.



Structure of fibroid tumor.

The *treatment* of these tumors is in a great measure palliative; but when they are so situated as to admit of removal, as in the neck, under the angle of the jaw, or in the antrum, they should always be extirpated.

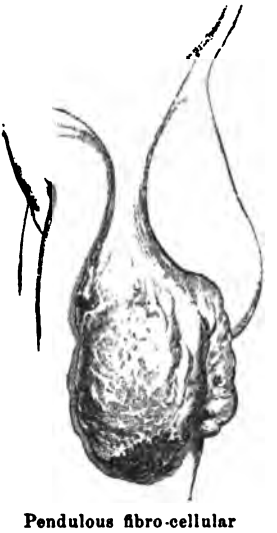
The *malignant fibroid tumor* closely resembles in its general appearance and microscopic elements the ordinary fibroid growths; but its great characteristic is its recurrence after removal, with much tendency to ulceration, sloughing, and hemorrhage. When it returns, it forms not only in its original locality, but in internal parts of the body at a distance from it.

c. Sarcomata.—This group is less defined, and the name has been applied rather vaguely by several writers; of late, indeed, the term sarcoma has included all the forms of tumors derived from the connective tissue, not excepting even the fibroplastic or myeloid varieties. It seems, however, desirable to restrict the name to the group now under consideration; which, although presenting varying degrees of departure from the normal type, have nevertheless certain very important features in common. These common characters are as follows: an intercellular substance presenting a certain degree of fibrillation, rarely so well marked as that seen in normal connective tissue, sometimes indeed very imperfect; it is usually rather soft,

and often contains much fluid in the meshes of the stroma. Imbedded in this matrix are cell-structures varying much in number and size, sometimes thinly scattered, elongated, and spindle-shaped, sometimes of a more oval or caudate form and collected into small groups. Each cell usually contains a single well defined nucleus and nucleolus; sometimes, however, the nucleus so completely fills the body of the cell that its presence is not easily recognized. Any two individuals belonging to this group may be considered much unlike one another, and it is only by comparing the intermediate forms that their relation to one another can be recognized.

The *areolar tumors* are little more than a simple hyperplasia of the subcutaneous or submucous areolar tissue. These are represented by pendulous sarcomatous growths forming large tumors commonly called *wens*, which may occur on any part of the surface. They are smooth, pedunculated, firm, somewhat doughy, but non-elastic, pendulous, and movable, slowly increasing without pain often to a very great size. It is in warm climates, and in the Hindoo and Negro races, that they attain their greatest development, having been met with fifty, seventy, and even a hundred pounds in weight. They are chiefly seated about the genitals, enveloping the scrotum, penis, and testes in the male, or depending from the labia of the female. That remarkable enlargement of the leg occurring in the Mauritius and some parts of the West Indies, and hence termed Barbadoes leg, is an affection of this kind. In structure these growths appear to be a simple hypertrophy of the fibro-cellular element of the part affected, being composed of a loose, reddish stroma moistened with a serous fluid. In the *treatment* of these affections, pressure and iodine applications may be tried in the earlier stages, with the view, if possible, of checking their growth; at a later period they must, if large, be removed by operation, though this procedure is at times an extremely severe one, owing to the great magnitude they attain.

Fig. 189.



Pendulous fibro-cellular tumor.

The *fibro-cellular tumors*, described cursorily by many writers as *cellular* tumors, have been more fully examined by Paget. They are not of common occurrence; and when met with they are most frequently found in the scrotum, the labium, the deep muscular interspaces of the thigh, and on the scalp, in which situation they form large masses, attaining sometimes to a weight of many pounds. The accompanying Figure 189 is taken from a tumor of this kind, which I removed from the side of a woman. When they occur about the scrotum and labium, these tumors must not be confounded with elephantiasis of these parts, from which they may be distinguished by being limited and circumscribed masses, and not mere outgrowths. They happen only in adults who otherwise are in good health, and grow quickly, forming soft, elastic, rounded, and smooth tumors; they are not attended by any pain. After removal they are found to possess a thin capsule, to be of a yellowish color, and to contain a large quantity of infiltrated sero-plastic fluid, which may be squeezed out abundantly, and coagulates on standing. Under the microscope they display a fine areolar stroma, consisting of undulating filaments or fibrous bands, in the midst of which abundant nuclei appear, which are rendered more distinct by the action of acetic acid. Elongated fibre-cells are also to be seen scattered amongst the fibres. As these tumors are perfectly innocent, no hesitation need be entertained about their removal.

Closely allied to these last in nature and origin, but presenting some special characters and representing a still greater departure from the normal standard, are the formations called by Virchow *glioma* and *myxoma*. *Glioma* arises from the neuralgia or delicate connective tissue of the brain and retina, and in it the cells bear a greater proportion to the intercellular substance than in any of the growths above described. *Myxoma* presents a still greater excess of cell-structures, the intercellular substance being remarkably soft, and yielding mucine instead of gelatine on boiling. The structure is very similar to that of the umbilical cord. It constitutes some forms of soft mucous polypi.

The *recurring fibroid tumor* may be considered as standing at the extreme end of

the list of the sarcomata, and as presenting many characters which connect it with the true fibro-plastic or myeloid type. Here the cells are numerous and constitute a very large proportion of the tumor; the intercellular substance is very imperfectly fibrillated, usually granular and containing nuclei. The cells are elongated, fusiform, or branched, and usually each contain a single distinct nucleus. It is described by Paget as closely resembling in general aspect the common fibroid tumor, whilst in its microscopic structure it is very like the fibro-plastic tumor, its most marked character being its tendency to recur after removal. Of this peculiar and hitherto undescribed disease he relates several cases. One was a tumor of the upper part of the leg, which between 1846 and the end of 1848 had been removed five times, and reappeared for the sixth time after the last operation, when, as it had become large and ulcerated, amputation was deemed advisable; this procedure, however, was followed by death. The examination of this tumor presented "very narrow, elongated, caudate, and oat-shaped nucleated cells, many of which had long and subdivided terminal processes." In another case, a tumor of the shoulder had been removed, and returned four times between May, 1848, and December, 1849, reappearing in the following year for the fifth time; it, however, after a time became stationary, and many years afterwards the patient, but for the presence of the tumor, might be considered a strong and healthy man. Paget also relates a case by Gluge, in which a similar tumor was five times removed from the scapula, its sixth reappearance being followed by death. The most interesting of all is a case by Maclagan, in which, after three removals in the course of twenty-five years, no further recurrence of the disease took place, and the patient was in good health five years after the last removal. Since this form of tumor was first described by Paget, a number of instances have been recorded by British and Continental surgeons. It is a remarkable circumstance that these recurrent tumors appear to become more malignant in their growth in the later than in the earlier recurrences, acquiring more and more the characters of true malignant disease, becoming more painful, rapidly degenerating, and giving rise to an ulcerating fungus, which eventually proves fatal by exhaustion and hemorrhage.

The sarcomata have all more or less a tendency to local recurrence, the later members of the group having a greater tendency than the earlier ones, but they infinitely rarely, if ever, appear as secondary deposits in internal organs, and this constitutes an important distinction between them and the members of the next group. It must be remembered, however, that some authors apply the term "sarcomata" to all the connective tissue tumors.

(*d.*) *Fibro-plastic and myeloid tumors* unquestionably give rise at times to secondary deposits in distant parts, and have a very remarkable tendency to local recurrence unless removed at an early period. These tumors present themselves under two forms: the true *fibro-plastic tumor*, consisting almost exclusively of elongated fusiform cells, containing for the most part a single oval or oat-shaped nucleus and nucleolus (Fig. 190)—to this tumor the name "spindle-celled sarcoma" has been given; and the true *myeloid tumor*, consisting of large multinucleated vesicular or plate-like cells, analogous to those found in the fœtal marrow, measuring from $\frac{1}{300}$ to $\frac{1}{1000}$ of an inch in diameter, and containing from two to twelve oval nuclei with distinct and highly refracting nucleoli. These two forms are intimately connected together; so much so, that it is rare to find a tumor which does not present some trace of transitional structure, and it is not uncommon to find the myeloid elements appearing in greater numbers on the recurrence of the tumor. An important character of these growths is the very great proportion which the cells bear to the intercellular substance; the latter is often scarcely to be recognized, being represented by a soft colloid material, with here and there fibrous bands, which divide the cells into groups, and give the tumor a lobulated appearance. These tumors may be found in connection with any of the fibrous membranes, but more especially with the periosteum; in fact, they may be looked upon as periosteal and endosteal tumors, *par excellence*. It is probable that the myeloid cells never occur in those forms which are unconnected with

Fig. 190.

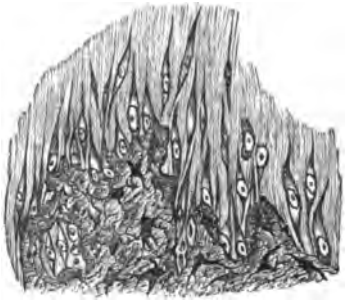
Fusiform and oat-shaped cells from myeloid tumor.

bone; and some writers have attempted to dissociate the two forms of tumors, and to describe those containing the true myeloid plates under the name "Tumeurs à Myéloplaxes" (Dr. Eugène Nélaton) (Fig. 191). That these are, however, merely varieties of the same formation, the following case, which occurred under my care

Fig. 191.

Myeloid plates or plate-like cells from a tumor of the lower end of the femur.

Fig. 192



Fibro-plastic tumor springing from the scapula.

at University College Hospital, sufficiently indicates. A tumor as large as a full-sized turnip was removed from the shoulder of a middle-aged man, and was found to be slightly connected with the spine of the scapula. On examination, it presented all the naked eye and microscopical characters of a fibro-plastic growth, consisting almost entirely of densely packed fusiform cells, with oval or oat-shaped nuclei; some few oval and caudate cells being scattered amongst them (Fig. 192). A small mass reappeared before the wound had completely closed, and on examination presented a much larger proportion of oval and caudate cells with multiple nuclei (Fig. 193). It recurred a second time; and was now found to consist almost entirely of large oval, plate-like or flask-shaped cells, with very numerous nuclei, whilst comparatively few of the true fibro-plastic cells

Fig. 193.

Cells from fibro-plastic tumor of scapula: first recurrence.

Fig. 194.

Microscopic characters of the tumor after its removal the second time. Multinucleated myeloid cells.

were found (Fig. 194). A portion of the spine of the scapula, which was removed with the tumor, showed that the growth had sprung from the cancellous structure of the bone.

Myeloid tumor was first fully described by Lebert, and is probably the *albuminous sarcoma* of Abernethy. Its clinical and anatomical characters have been carefully investigated by Paget, who considers it as intermediate in structure between the fibroid and fibro-cellular forms. It is found about the jaws, in the bones, the hands and feet, in the areolar tissue of the neck, over the parotid, in the mammary gland, and frequently in connection with the mucous cavities and canals, as in the rectum and nasal fossa. The tumor presents well-marked physical characters. On making a section, it cuts in an uniform, smooth, and somewhat elastic manner; it is semi-transparent, shining, and juicy-looking, of a greenish-gray, bluish, or pinkish color, like the albumen of some birds' eggs, often spotted or stained with discolored

marks, varying in tint from a blood to a pinkish, brownish, or livid red hue, which, if extensive, gives it a fleshy look: its structure is usually brittle. After a time it breaks down in the interior into a dark brown grumous glairy fluid, contained in cysts formed by the parenchyma of the growth. This tumor will grow to a very large size, sometimes slowly and gradually, at other times with very great rapidity (Fig. 195). I have removed it from the parotid region when as large as the fist, and from the breast weighing as much as six pounds. It most commonly occurs in young people, without pain and without any known cause. In the majority of cases it may be safely removed without the prospect of recurrence, but occasionally, and without any apparent reason, it returns after removal. Most generally it is distinctly encapsuled when occurring in the neck and breast, and then may be extirpated with ease and safety; but if its degeneration have gone on to infiltration into the neighboring structures, its recurrence will speedily take place. Lebert relates six cases of this disease in which recurrence took place after operation with secondary deposits in internal organs.

Fig. 195.

Myeloid tumor of radius.

(*e.*) *Granulation tumors.*—Under this head Virchow has classed several remarkable formations, viz., the syphilitic tumors; whether affecting the entire organ as in syphilitic sarcocele, or appearing merely as isolated masses, as the gummy tumors; lupus, and its allied forms; elephantiasis; and the products of farcy. These he considers to be connected together by a certain similarity of structure, which resembles that of imperfectly formed connective tissue. Many of these formations have been looked upon as the products of inflammation, but it would appear more reasonable to consider them as the results of the action of a specific poison upon the nutrition of the areolar tissue.

2. **Tumors derived from or formed upon the type of Cartilage.**—To all these the generic term *enchondroma* is applied, whether they be entirely composed of a substance having the structure of true cartilage, or whether this constitute only a portion of the mass.

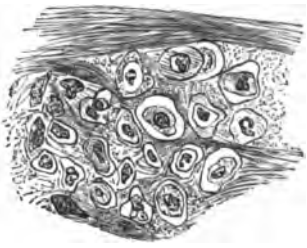
Enchondroma, or the *cartilaginous tumor*, carefully studied by Müller, and investigated by Paget, is an exceedingly interesting affection, whether we regard the peculiarity of its structure, its comparatively frequent occurrence, or the large size that it occasionally assumes. It takes place under two distinct forms; most commonly as an innocent growth, but in other cases assuming a malignant tendency and appearance. These two forms present different signs. In the first case, the enchondroma occurs as a hard, smooth, elastic, ovoid, round, or flattened tumor, of small or but of moderate size, seldom exceeding that of an orange, and growing slowly without pain. In the second form, it approaches in its character to malignant disease, growing with extreme rapidity, attaining an enormous size within a few months, and contaminating the system by the deposit of secondary enchondromatous growths in internal organs; in these circumstances, it would appear to have occasionally been mistaken for the rapidly spreading forms of encephaloid disease. But, although they occasionally assume the course that is usually adopted only by true malignant growths, enchondromata, especially of the testes, are not unfrequently associated with encephaloid; and when this occurs, the secondary deposits are usually of the latter character only, being in rare cases of a mixed nature.

When these growths attain a rather large size, though occasionally whilst they are still but of moderate dimensions, ossification may occur in some parts, whilst a process of disintegration may take place in others, which soften, break down, and liquefy in their interior, causing the skin covering them to become duskily inflamed, eventually to slough, and to form fistulous openings, through which a thin jelly-like matter is discharged. In some cases it would appear that large tumors of this description, softening in the centre, and becoming elastic and semi-fluctuating, have been mistaken for cysts, and have been tapped on this supposition. In small enchondromata the opposite condition more frequently occurs, the tumor becoming indurated, and undergoing ossification.

Microscopical characters.—Although in many respects the structure closely re-

sembles that of normal cartilage, and especially that variety known as fœtal cartilage, yet there are certain peculiarities which may often serve to distinguish the two. In the more typical forms the cells are preternaturally large and round, whilst in other cases they are irregularly polygonal, shrivelled, or branched; they are not, as a rule, equally distributed through the matrix, but are collected into groups. Their diameter varies from $\frac{1}{300}$ to $\frac{1}{800}$ of an inch, and they contain a single large nucleus and nucleolus (see Fig. 196). In the rapidly growing forms the cells are often granular, and are evidently undergoing fatty degeneration. The matrix is either hyaline, coarsely granular, or fibrillated, and usually contains some calcareous or ossific deposits. The process of ossification is rarely complete, stopping short as a rule before the formation of true bony tissue. The matrix is often traversed by fibrous bands, which sometimes produce a retiform appearance. In the larger and more rapidly growing tumors, these bands are of considerable size, and convey vessels, sometimes giving rise to much vascularity. An enchondroma usually increases by endogenous cell-growth, but occasionally by invading the surrounding structures in contact with it.

Fig. 196.



Structure of enchondroma.

Locality.—Most frequently enchondroma occurs in connection with some of the short bones, more particularly those of the metacarpus and the phalanges of the fingers (Figs. 197, 198), presenting hard rounded knobs in these situations, where, however, it seldom attains a greater magnitude than a walnut or a pigeon's egg. When large, it is commonly met with in or upon the head of the tibia or the condyles of the femur, forming in these situations rapidly increasing growths of considerable magnitude. It may also form in the parotid region, in the muscular interspaces of the neck, thigh, and leg, and in the testes. When connected with the bones, enchondroma may either spring from the periosteum, gradually enveloping, absorbing, and eventually destroying, the osseous structures, though at first not incorporated with them. This is its usual mode of origin when occurring in the femur or tibia; when seated on the short bones, especially on the metacarpus and phalanges (Figs. 197, 198), it commonly springs from the interior of the osseous

Fig. 197.

Large enchondroma of index finger.

Fig. 198.

Ordinary enchondroma of finger.

structure, expanding, absorbing, and involving its walls in the general mass of the tumor. When occurring in cellular regions unconnected with bone, the enchondroma is softer, and does not present such distinct cartilage-cells as the osseous enchondroma. Most frequently these enchondromatous masses occur in childhood, or shortly after puberty, appearing to arise from an overgrowth of the cartilaginous element of the osseous system at this period of life.

The *treatment* consists either in excision of the tumor, or in amputation of the affected part. Excision may be practised when the tumor is seated in the parotid region, or otherwise unconnected with bone. When forming part of the osseous structures, it cannot well be got rid of without the removal by amputation of the bone that it implicates. When it occurs in the hand, removal of the affected fingers and metacarpal bones, to an extent proportioned to the amount of the disease, will

be required. In Fig. 20 may be seen the kind of hand left after operation in the case from which Fig. 198 was taken. If in these circumstances, excision of the tumor only be attempted, it will be found that the whole mass cannot be removed, and that it rapidly grows again; or that the wound formed by the operation remains fistulous and open. Most commonly a permanent cure is effected by the ablation of the tumor in one or other of these ways; but cases have occurred of the more rapidly growing form of the disease recurring, after its removal, in a softer state than before, and with a close approximation to malignancy in appearance and action.

It is worthy of remark, as showing the connection between enchondroma and malignant disease, that cartilaginous masses have been met with in the midst of encephaloid tumors of the bones and testes.

3. **Tumors derived from or formed upon the type of Bone.**—This group includes three principal varieties: the exostoses, osteosarcomata, and malignant osteoid. It will prove more convenient, however, to consider their anatomical structure together with their clinical characters in the chapter devoted to the diseases of bone.

IV.—TUMORS OF THE EPITHELIAL TYPE.

The general features presented by this type of structure have been already explained, and it will be found that the tumors now to be considered represent an attempt to return to the same standard, this result being most completely realized in the epithelioma. The members of this group constitute the *cancers*, and are not only the most heterologous in structure, but the most malignant in progress, of the whole series of new formations now under consideration.

Cancer.—Before proceeding to the individual growths forming this class, it will be desirable to say a few words upon the subject of cancer generally.[1] The term has been very vaguely applied, the older pathologists placing under this head all growths which presented a malignant aspect, intense rapidity of growth, or recurrence after operation; thus several of the tumors already described have been considered to be cancers. The occasional coexistence of true cancer with cartilaginous, bony, or erectile tissue, has given rise to special varieties called respectively chondroid, osteoid, and aneurismal. Accidents of structure or appearance have been designated by special names, as cystic, villous, fungoid, melanotic, &c., and thus much confusion has resulted.

Cancers may be conveniently divided into three groups, which must not, however, be taken as possessing any positively distinctive characters, but merely as types of certain important varieties, viz: encephaloid, soft or acute cancer; scirrhus, hard or chronic cancer; and epithelial or integumental cancer. This division will be found to facilitate the study of the numerous minor varieties which occasionally present themselves.

Viewing the three varieties of cancer above enumerated as formed upon a common type, we cannot be surprised at finding very numerous points of resemblance existing amongst them; thus one form of cancer may take the place of another, or be associated with it; encephaloid occurring after the removal of scirrhus, or being associated with a structure allied to epithelioma. This identity of seat and of recurrence, which tends more than anything else to establish a common origin amongst these tumors, has been specially pointed out by Carswell. Then, again, these tumors are all of a truly malignant character, having a tendency to induce a peculiar and similar condition of system that goes by the name of the *cancerous cachexy*. In chemical composition, also, they are nearly identical, being principally composed of albumen.

We will now describe and compare the *scirrhus* and *encephaloid* cancers: the

[1] It is not my intention to enter largely into the general history of malignant diseases, as space will not admit of my doing so; I would therefore refer my readers, who wish for further information on this interesting subject, to the works of Abernethy; the papers by Lawrence; the admirable and magnificent *Illustrations of the elementary forms of disease*, by Sir R. Carswell; to the excellent and copious monograph by Walshe; and to Paget's philosophic lectures on this subject. Amongst the foreign works may be mentioned *Traité des tumeurs*, by Broca; and Billroth's *Handbook of general and special surgery*, and *surgical pathology*.

epithelial forms, presenting some very marked peculiarities of structure, will be more conveniently considered apart from the others.

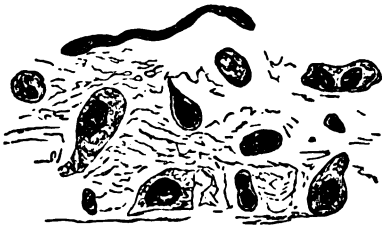
Microscopic Structure.—The microscopic characters of the different forms of cancer have of late years attracted considerable attention amongst pathologists. They consist, in all the varieties, essentially of the same elements, though these may differ somewhat in appearance, and in relative preponderance, in the different forms of the affection.

A cancer always presents a heterogeneous commingling of cells and fibres with an intercellular substance in the form of a suspending fluid, which varies much in quantity, being scarcely recognizable in the epithelial varieties. The cells are always grouped irregularly, and lie in close contact with one another (Fig. 199.) It is much disputed, whether there is any fibrous stroma properly belonging to the cancer, and whether the fibrous structures always present to a greater or less extent in these growths really only represent the remnants of the pre-existing tissues invaded by the tumor. Certainly the tendency of the formation is to revert to a type, the distinctive feature of which is the absence of intercellular substance. These tumors yield by scraping or pressure a turbid fluid, termed the *cancer-juice*,

Fig. 199.

Scirrhus of breast: showing cells and fibres.

Fig. 200.



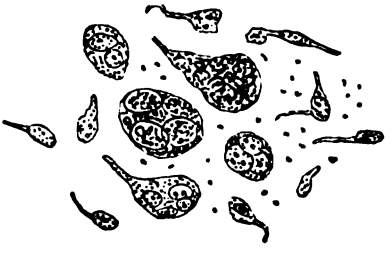
Scraping from scirrhus of breast.

in which granules, cells, pigmentary and fatty matters, are found in varying proportion (Figs. 200, 202). The *granules*, which are minute, sometimes amorphous, at others presenting that peculiar vibratory condition termed the molecular movement, are met with in all the varieties of cancer, though they occur in largest quantity in scirrhus. The *cells* have often been looked upon as characteristic or pathognomonic of the disease, though erroneously so in the strict acceptation of the term; they present characters, which are so far distinctive, that, when they are viewed in connection with the other elements of the growth, it is not difficult to determine the true nature of the formation. It must, however, be remembered that no decided opinion can be formed concerning the character of any growth from the examination

Fig. 201.

Cells from encephaloid of tongue (rapidly recurring). Magnified 300 diameters.

Fig. 202.



Cells from scirrhus of breast (rapidly recurring). Magnified 300 diameters.

of a few isolated cells; the general arrangement of the elements, and the mode in which the tumor invades the surrounding tissues constituting far more important

aids in determining this point. Cancer-cells are usually large, spherical, fusiform, spindle-shaped, diptychal, or caudate, with one or more large nuclei placed excentrically, each containing a prominent nucleolus, which however does not, as a rule, present that glistening highly refractive appearance commonly seen in the fibroplastic growths. In *encephaloid* the cells present a very great variety of size and form; they are most commonly round, oval, or slightly caudate, varying from $\frac{1}{1500}$th to $\frac{1}{4000}$th of an inch in diameter, and they contain usually a single large ovoid nucleus and distinct punctiform nucleolus (Fig. 201). These cells rapidly undergo fatty degeneration, and appear like minute, dark, finely granular balls, which break down very rapidly. The cell wall is readily affected by dilute acetic acid or potash, the nucleus being rendered more distinct by these reagents. The cells of *scirrhus* are larger, varying from $\frac{1}{700}$th to $\frac{1}{3000}$th of an inch in diameter, more irregular in outline, often appearing shrivelled or withered; they frequently present two or more nuclei which are large, prominent, oval, and nucleolated (Figs. 200, 202). The cell contents are granular; and the cells are frequently found undergoing fatty degeneration, as in the encephaloid forms. A large amount of granular *débris* and molecular matter is to be seen amongst the cells. The relation of the growths to the surrounding structures can only be studied by examining sections, taken after the mass has been hardened in a solution of chromic acid (two per cent.) (Fig. 203). A cancer will then be found to invade the neighboring parts in such a manner, that no satisfactory line of demarcation can be drawn between it and the normal structures.

Much diversity of opinion exists amongst surgeons as to the value that should be attached to these microscopic signs in determining the true nature of many tumors; some being guided by these appearances alone, others looking upon them as uncertain and fallacious, and trusting rather to the general characters of the growth. The latter, however, appears to me to be too limited a view of the subject; for, although the unaided eye of an experienced surgeon may in many cases recognize the true character of a tumor, and the microscope in some few instances fail to afford much additional information, yet there can be no doubt that in most cases it is only by the aid of this instrument that the real nature of the growth can be absolutely determined.

Fig. 203.

Scirrhus of breast, hardened in chromic acid; showing stroma.

It is doubtless true that every one of the microscopic elements above described may separately occur in the normal tissues and secretions of the body, some in the adult, others, as the caudate and fusiform corpuscles, in the embryo; but, though this be the case, it does not appear that they are ever found similarly grouped in any tumors, except those of a cancerous nature; and in these it is rather by the aggregation of these appearances, than by any single one in particular, that the true character of the disease is determined. In his examinations, however, the experienced surgeon will find that the appearances presented to the naked eye will assist him much in pronouncing upon the malignant or cancerous character of the tumor. It is certainly a remarkable circumstance, that the "recurring" or semi-malignant diseases, as well as those that are truly cancerous or positively malignant, present under the microscope structures that closely resemble those of tissues in process of development, either in the form of imperfect exudation-matter and fibro-areolar tissue, as in the fibro-plastic tumors, or of the corpuscles of encephaloid, which resemble some of those of the soft tissues in the embryo.

Progress.—The general characters that attend the progress of the scirrhous and encephaloid forms of cancer present numerous points of resemblance. When once formed, the tumor continues progressively to increase in size with a degree of rapidity, and to an extent, that vary according to its kind; the scirrhous tumor growing most slowly, and attaining but moderate dimensions; the encephaloid often with great rapidity, and to an immense size. When the full growth of the tumor has been attained, the process of decay commences. The mass softens at some point, the skin covering which becomes duskily inflamed and ulcerated, and an irregular sloughy aperture forms, through which the *débris* of the mass are eliminated in an

ichorous or sanious fluid, having often a peculiar fetid smell. The ulcer then rather rapidly increases, with everted edges, a hard and knobby, or soft and fungating surface, and the discharge of a dark fluid, often attended by hemorrhage, and occasionally with sloughing of portions of the mass. Coincidently with the implication and ulceration of the skin, there is usually deposit in the lymphatic glands with great increase of pain, and most commonly with the supervention of the constitutional cachexy; though in some cases this condition precedes the cutaneous implication. This cachexy appears to be the result of the admixture of cancer-germs with the blood, and their circulation through the body; or of some other modification in the condition of the blood, induced by the action of the morbid growth on the economy. The exhaustion resulting from the ulceration, sloughing, and consecutive hemorrhage, also commonly increases this cachectic state; in many instances it is not marked until after the skin has become affected, and in others it does not supervene until ulceration is actually set up. In this cachexy the countenance is peculiarly pale, drawn, and sallow, so that the patient has a very anxious and care-worn look. The general surface of the body commonly acquires an earthy or yellowish tint, and not unfrequently large spots of pityriasis or chloasma make their appearance on various parts of it; the appetite is impaired, the voice enfeebled, the muscular strength greatly diminished, and the pulse weak. The patient complains of pains in the limbs, of lassitude, and of inability for exertion; he emaciates rapidly, and frequently suffers by the occurrence of cancerous deposits in internal organs; and at last dies from exhaustion, induced by the conjoined effects of weakening discharges, general debility, and pain.

These general characters of cancerous growths present certain varieties of importance, according to the form of the disease that is developed.

Scirrhus.—The scirrhus, or *hard* cancer, is most commonly met with as a primary deposit in the female breast, in various portions of the alimentary canal, as the œsophagus, the pylorus, the sigmoid flexure of the colon, and the rectum, in the tongue, the penis, and the skin; secondarily, in the lymphatic glands. It occurs in two forms; either as a circumscribed mass, or infiltrated in the tissue of an organ. In either case it forms a hard, craggy, incompressible, and nodulated tumor, at first movable and unconnected with the skin, but soon acquiring deep-seated attachments, and implicating the integument. It grows slowly, seldom attaining a larger size than an orange. At times painless, at others it is painful, aching generally, occasionally with much radiating and shooting pain through it. These sensations vary according to the part affected, and to the sensibility of the individual; the pains are especially severe after the tumor has been handled, and at night are of a lancinating, neuralgic character. It may thus contine in a chronic state for a considerable length of time, slowly increasing, gradully extending its deeper prolongations, and implicating the more superficial parts. In some cases, more particularly in elderly people, scirrhus gives rise to atrophy of the organ in which it is seated, causing wrinkling and puckering of the surrounding skin, which becomes adherent to the tumor; and the cancer may thus continue in a very chronic state.

The ulceration usually takes place by the skin becoming adherent at one point to the tumor, either by dimpling in, being as it were drawn down towards it, or else by being pushed forwards, stretched, and implicated in one of its more prominent masses; it then becomes of a dusky and livid red, somewhat glazed, and covered by a fine vascular network. Softening occurs at one point, where a crack or fissure forms; a clear drop of gummy fluid exudes from this, and dries in a small scab upon the surface; this is followed by a somewhat bloody discharge of a thick and glutinous character; and the small patch of skin from which it issues, becoming undermined, speedily sloughs away, leaving a circular ulcer. This gradually enlarges, becoming ragged and sloughy, with craggy everted edges, having irregular masses arising from its surface, and discharging a fetid sanious pus. The pain increases greatly; and, the lymphatic glands becoming involved, the cachexy is fully developed, and the patient is destroyed by it or by the secondary visceral deposits. In old people, ulceration of scirrhous masses often assumes an extremely chronic character, the growth in them not being endued with the same vitality as in the young. The ulcer in these cases is flat, sloughy, of a grayish-green color, hard and rugged, with puckered edges, and much wrinkling of the surrounding skin, and exhaling the usual fetid odor. In younger persons, and especially in stout women with florid complexions, the disease usually makes rapid progress. So also, if inflammation be

accidentally set up in the neighboring tissues, cancerous infiltration takes place in them, in consequence probably of the products of inflammation effused around the tumor undergoing cancerous transformation almost as soon as deposited. I once had under my care an old man with a cancerous tumor of the leg, which, after remaining stationary for seven years, became accidentally inflamed, and afterwards increased with great rapidity. Occasionally, but very rarely, scirrhous masses slough out, leaving a large ragged cavity, which may even cicatrize; and thus a spontaneous cure has been known to occur. The cancerous infiltration will extend to a considerable distance around the tumor into integument which to the naked eye appears quite healthy, but with the microscope will afford unequivocal evidence of the existence of cancer-germs diffused through it. The cancer-infiltration extends like a halo around the original tumor, and very probably shades off into the surrounding textures. It is of great importance in determining the question of operation to bear this in mind, and not to act on the supposition of the tumor being distinctly and abruptly defined.

The secondary deposits from scirrhous tumors may take place in the viscera, more particularly the lungs or liver, or in the lymphatic glands; in the former situation, they are often of an encephaloid character, in the latter they assume the scirrhous form.

Structure.—After a scirrhous tumor has been removed, though still feeling firm under the fingers, it is not so hard as when it was in the body; owing, as Walshe observes, to the escape of its fluids and consequent loss of turgescence. On cutting it with the scalpel, it usually creaks somewhat as it is divided, and presents a whitish or bluish-white glistening surface, intersected by white bands, which apparently consist partly of new structure, partly of included areolar tissue. This section has not inaptly been compared to the appearance presented by a cut through a turnip or an unripe pear, hence termed *napiform* and *apinoid* by Walshe; and from its reticulated character, *carcinoma reticulare*, by Müller. On examining the fibrous stroma or network which forms the basis of the tumor, it will be found to be composed of fibrous or fibrocellular tissue. The soft grayish-blue granular material seated in the meshes of this, may be squeezed or scraped off in a liquid state as cancer-juice. This is composed of a multitude of nucleated corpuscles, granules, granular cells, and globular, caudate, or spindle-shaped bodies.

Encephaloid.—The encephaloid or soft cancer, or, as it is often termed, *medullary sarcoma*, is the most malignant and rapidly growing form of this disease. It is met with in the globe of the eye, in the nares and other cavities of the face, in the articular ends of bones, in the testes, and the breast, and often attains an enormous size, equal to that of an adult head. It occurs in two stages; either as a tumor, encysted or infiltrated, or as a fungus after protrusion through the skin.

It commences as a tumor, which, though occasionally somewhat hard, is usually from the first, or at all events soon becomes, soft and elastic, being more or less lobulated, growing rapidly, and having an elastic and at last a semi-fluctuating feel. The skin covering it is usually at first pale and loose, with a large network of dilated veins spreading over it. In some cases, however, at a very early period, a species of inflammatory œdema occurs in the integuments covering rapidly growing encephaloid tumors. As the tumor enlarges, the skin becomes adherent, discolored, of a purple-brown tint, and at last ulcerates at one point. When once the tumor has made its way through, and is relieved from the pressure of the fascia and integuments, the rapidity of its growth becomes fearfully increased; and a large soft fungous mass, rugged, irregular, dark-colored, and bleeding profusely, rapidly sprouts forth, constituting the affection to which Hey gave the appropriate term of *fungus hæmatodes;* when this condition has been reached, death rapidly ensues from exhaustion and hemorrhage. Pulsations have been met with in particular forms of very vascular encephaloid; in these cases also a loud bruit synchronous with the pulsation and the heart's action has been detected, and may be heard on the application of a stethoscope. These symptoms have been most frequently met with in encephaloid tumors connected with bone, and may, unless care be taken, cause the disease to be confounded with aneurism.

The constitutional cachexy in encephaloid occurs early, and is well marked; and secondary affections of the lymphatic glands and viscera, occasionally of a scirrhous character, often take place.

Structure.—After removal, the tumor is found to be very vascular, displaying

on injection a close network of vessels. On a section being made, it commonly presents a soft pulpy white mass, closely resembling cerebral substance, stained and blotched with bloody patches, varying in color from a bright red to a maroon-brown, this being dependent on blood that has been infiltrated into its substance. In other cases its section has been compared to that of a raw potato, or a piece of boiled udder. On closer examination, its tissue will be found to consist of a stroma of delicate fibres supporting the soft medullary or brain-like structure; this is composed in a great measure of large quantities of corpuscles, nucleated, compound, and granular, fusiform, angular, clubbed, or caudate, often with two terminations.

Other Varieties of Cancer.—Special names have been given to varieties of cancer, dependent merely on peculiarities of appearance or structure. Two only of these varieties, however, the *colloid* and the *melanotic*, require notice in this place.

Colloid, *gelatinous*, or *alveolar cancer* may occur in distinct masses, often of a very large size, weighing many pounds, or may be infiltrated into the tissue of organs; as it is most commonly met with in the viscera of the abdomen, it does not so often fall under the observation of the surgeon as the other varieties of cancer. Yet it may form superficially. I have met with it in the breast, forming a very large tumor; and there is a preparation in the University College Museum of a scirrhous breast containing colloid.

It consists of cells filled with a clear semi-transparent yellowish gelatinous or honey-like material, resembling indeed exactly the structure of a honey-comb. The septa forming these cells are distinctly fibrous, and regular in their arrangement. The gelatinous matter contains caudate and nucleated cells in considerable quantity, presenting the same characters as those of the other varieties of cancer.

There is a growing belief among pathologists that this variety merely represents, as it were, an accident of structure, viz., the gelatinous condition, and that the tumors to which the name has been applied really belong to one of the three following classes:—

1. Glandular formations in which the cells have undergone colloid change, as in the so-called colloid cancer of the mucous membrane of the stomach and intestine.
2. Fibro-plastic tumors, with an unusual amount of gelatinous intercellular substance and well-marked fibrous septa, containing elongated spindle-shaped cells, with a few more oval or caudate. This form is chiefly found in the inter-muscular fibrous septa.
3. True cancers, either encephaloid or scirrhus, in which the cells have undergone colloid degeneration.

Melanosis or *black cancer* has been specially studied by Sir Robert Carswell, who arranged it under the heads of *punctiform melanosis*, in which the dark pigmentary matter occurs in the shape of minute points or dots scattered over a considerable extent of surface; *tuberiform melanosis*, occurring in tumors which vary in bulk from a millet seed to an egg or an orange, always assuming a globular, ovoid, or lobulated shape, and being principally met with in the areolo-adipose tissue, or on the surface of serous membranes; and *stratiform* and *liquiform melanosis*, which takes place principally upon serous membranes, or in accidental cavities, where the black pigmentary matter looks not unlike Indian Ink. Melanosis most frequently presents itself to the surgeon in connection with the eye, occasionally in the skin and subcutaneous areolar tissue, and rarely in the bones. It closely resembles in its general progress and characters the encephaloid form of cancer, ulcerating and throwing out dark fungous masses, and affecting like it internal organs, more particularly the eye and the lungs. Paget, indeed, regards melanosis as being, with very rare exceptions, merely medullary or encephaloid cancer modified by the deposition of black pigment. Occasionally, as Carswell has pointed out, it is distinctly associated with the other varieties of this disease. In microscopic structure it resembles encephaloid, consisting of a stroma, with caudate, granular, and compound cells, but containing a large quantity of pigmentary matter in granules, molecules, and masses.

Diagnosis.—The diagnosis of the different forms of cancer is not always easily made. *Scirrhus*, when in tumor, may very readily be confounded with fibrous tumors and chronic glandular masses, or with the indurated atrophy of a part; in many of these cases, indeed, the diagnosis cannot be correctly affected until after removal. In other cases, however, the rugged feel, the lancinating pains, the tend-

ency to the implication of the lymphatics, or to affection of the general health, will commonly serve to establish the diagnosis. When ulceration has taken place, the previous condition of the tumor, the general character of the sore, and the microscopic examination of the *débris*, may serve to establish its true character.

Encephaloid in tumor may be confounded with abscess, with cysts, or with fatty, erectile, and sanguineous tumors; and, when pulsating, with aneurism. In these cases careful palpation, the existence of elasticity without fluctuation, and the presence of the large and tortuous veins ramifying over the surface of the mass, may establish its true character. When it is fungating, it might be confounded with the sprouting intracystic growths, that sometimes spring from the interior of a cystic tumor. Here, however, a microscopic examination of the *débris*, as well as the existence or absence of contamination of neighboring lymphatics, will establish the true nature of the affection.

Causes.—The causes of cancer are often exceedingly obscure. In many cases it undoubtedly is of an *hereditary* character. Nothing is more common than to find that the grandmothers, mothers, or aunts of patients affected by cancer, have died of the same disease. Velpeau says that it was so in more than one-third of the patients he has met with; not that the disease itself is existent at birth, but that the tendency to it is connate; that tendency manifesting itself at those periods of life and in those organs in which cancer usually develops itself. It may, however, actually be a congenital affection; thus it has been met with in the eye at birth, and, in the Museum of University College, is a preparation of a small melanotic tumor existing in the cerebellum of a child that only lived three days after birth. It may occur at all periods of life from the earliest ages; and will evince itself in persons from eighty to ninety years of age. According to Walshe, the mortality from cancer goes on steadily increasing till the eightieth year; hence the popular belief, that the middle period of life is most obnoxious to it, would appear to be an erroneous one. Age, however, influences the liability to cancer in certain organs. Thus cancer of the eye and of the bones frequently occurs in children; of the testes, not uncommonly, in young adults; whilst, in the female, Sibley states that the average age of patients with uterine cancer is forty-three, and with mammary, forty-eight years. All forms of cancer are not, however, met with in equal frequency at all ages; the encephaloid being the most common in the young, and scirrhus in the middle-aged and elderly. The colloid variety rarely occurs before the age of thirty.

Mental emotions of a depressing character, if long-continued or frequently repeated, may possibly predispose to the occurrence of cancer. I have seen so many cases of cancer, more particularly of the abdominal organs, in individuals who had suffered much from grief, anxiety, or harass of mind for years before the development of the malignant disease, that, although the doctrine is incapable of proof, I cannot but look upon it as probable, that the cancer was the result of the antecedent long-continued mental disquietude. We know, by every-day experience, that functional derangement of the abdominal and pelvic organs of the most inveterate character may be occasioned by mental disturbance; and it appears to me not improbable, that such functional derangement may at last lead to perversion of nutrition, terminating in malignant deposits in such organs, as the uterus, the liver, or the stomach, as are more readily influenced by the condition of the patient's mind.

Cancer often appears without any *exciting cause*, when it is evidently, as in hereditary and connate cases, the result of some peculiar constitutional condition, the nature of which is altogether unknown to us, but under the influence of which the peculiar growth characterizing it springs up. In many cases, however, it can be distinctly traced to some exciting cause, being immediately occasioned by a blow, injury, or other violence, or by a long-continued irritation of the part that eventually becomes affected; thus in woman a blow on the breast often gives rise to cancer, and the irritation of a broken tooth may occasion it in the tongue. It is a question whether external causes of this kind can give rise to the production of cancer without the previous existence of constitutional predisposition to the disease. That cancer, even when apparently excited by local causes, may in reality be of constitutional origin, cannot admit of a doubt; more especially in those cases in which it is hereditary, or in which it makes its appearance almost simultaneously in different parts of the body, with a strongly marked cachexy. But in many other instances it certainly appears to be strictly local in its origin, as when it slowly occurs

after the infliction of some violence, and without any evidence of constitutional disturbance or contamination. Velpeau truly observes, that those organs which are most exposed to external irritation and violence, are most liable to cancer. It is impossible to look upon those cancers as *ab initio* constitutional, which arise from external causes in an otherwise healthy individual, and slowly increase in size without any tendency to multiplication or sign of constitutional cachexy, until by the implication of the neighboring lymphatics or glands the cancer-germs have entered and saturated the system. It is true, that it may be argued that the cancer could not be excited locally in these cases, unless a tendency to it already existed in the system. But this appears to me to be a begging of the whole question; there is no proof of the existence of any constitutional affection preceding or even concurrent with the outbreak of the disease, nor until it has existed for a sufficient length of time for the lymphatics to be affected and the blood to be poisoned; and it certainly appears to be more reasonable to look upon the local disease as the primary affection, occurring originally in a healthy constitution, but after a time infecting the system generally, than to regard the mere local manifestation as in itself a proof of the constitutional nature of the disease. It is true that we are ignorant of the manner how a cancer-germ can be produced by the local action of the part in which it is generated, but we are as little acquainted with the essential mode of production of an exudation-cell or of a pus-corpuscle, which we know to be the results of strictly local action; and it seems to me that the difficulty is in no way solved, but simply pushed back a step, by the attempt to prove that, in all cases of cancer-formation, a constitutional cause or predisposition exists, which impresses the cancerous character upon local actions taking place in such a system. The hereditary tendency to cancer in certain families is not necessarily a proof of its being a constitutional or blood-disease. We see the tendency to the hereditary transmission of malformations in strictly local diseases, as supernumerary fingers or exostosis; but we do not regard such conditions or such diseases as constitutional, merely because the tendency is transmitted from parent to offspring. The cases in which cancer appears to be primarily and strictly a local affection, influencing the constitution secondarily, are by no means of unfrequent occurrence. We commonly see, for instance, a woman in perfect health receive a blow upon the breast, which gives rise to some passing inconvenience at the time; after a lapse of some weeks, though still with an unimpaired state of health, she notices a small lump of a scirrhous character. This may continue stationary, or but slowly increase for months or years, and then comes the turning point in the case when the disease ceases to be local and becomes constitutional; this turning point is when the disease begins to contaminate the skin or the lymphatics, and thus to be carried into the system. It is not until the lymphatics become enlarged, and the glands in the axilla indurated, that the constitution begins to suffer, cachexy sets in, and a tendency to secondary deposits manifests itself—the constitutional cachexy developing as the ulceration and sloughing extend, and in exact proportion to the progress of the local affection. In such cases as these, it is in vain to argue that the cancer could not have sprung up unless there were a constitutional tendency to it. There is in these cases no evidence of any affection of the constitution, nor of any general predisposition to cancerous disease, until after sufficient time has elapsed for the germs to be absorbed, and the blood to be poisoned by them.

The cause of *secondary deposits* in internal organs, as the lungs and liver, is somewhat obscure. As has been already mentioned, the neighboring lymphatic glands usually, if not invariably, are the first to suffer; next in order of frequency follows the liver; and then the lungs. The fact that the secondary deposit does not necessarily occur in the organ through which the blood must first pass, militates, as Virchow has shown, against the theory that cancer-cells are carried onward by the circulation, and become impacted in the smaller vessels of the part, in the manner of embola. Virchow himself inclines to the belief that the cancerous juices are absorbed and enter the circulation either directly by the veins or indirectly through the lymphatics, and that they give rise to changes in the nutrition of certain parts leading to the development of cancerous growths. It is, however, confessedly difficult to understand upon this supposition, why the corresponding organ (as the breast) does not become affected; or why an organ like the uterus, peculiarly prone to cancerous development, does not speedily become the seat of secondary

deposits. Neither of these views can be considered altogether satisfactory, and neither has yet received the positive support of an actual demonstration.

Treatment of Cancer.—The treatment of cancer may be considered to be of a constitutional and of a local character. All *curative constitutional treatment* is, I believe, utterly useless in cases of cancer, no constitutional remedies appearing to exercise any material influence on this disease. I am not acquainted with any case of cancer, either from my own observations, from conversation with other surgeons, or from published statements, that affords satisfactory evidence of cure by an internal remedy. It is true that many so-called cases of cancer have, at various times, been stated to have been cured by different medicines; but it must be borne in mind that, in a less advanced state of pathological knowledge than exists at the present day, almost all hard chronic tumors were called "scirrhous," and many intractable ulcers "cancers;" mistakes which are not unfrequently committed, and sometimes unavoidably so, even with the improved means of diagnosis that we at present possess. Not one of the many remedies that have been vaunted as being specific in this disease, and by which cures have been stated to have been effected, has retained the confidence of the profession, or has, on further trial, corresponded in its effects to the statements of those who introduced it. I therefore think it but waste of time to discuss the supposed advantage to be derived from hemlock, sanguinaria, iron, arsenic, iodine, cod-liver oil, or lemon-juice, in the treatment of cancer. But, though curative treatment can effect nothing in these cases, much may be effected in cases that do not admit of operation towards retarding the progress of the disease by proper *palliative treatment.* With this view, the diet should be mild, nutritious, easy of digestion, unstimulating, and sufficient to support the strength under the wearing influence of pain and discharge; and the preparations of opium, of conium, and of hyoscyamus, must be freely administered in order to relieve the patient's sufferings, and to procure rest.

The *local means* are those upon which the surgeon justly places the chief reliance in these affections. The *palliative local treatment* consists in the use of means calculated to retard the growth of the tumor, to lessen the pain attending it, and to remove the fetor that arises if it be ulcerated. In order to prevent the rapid extension of the tumor, it is of great importance to subdue all local excitement going on within and around it; in proportion to the amount of action existing in the part, the disease will usually extend with rapidity; any inflammatory condition of the neighboring tissues being especially prejudicial in this respect. Hence, in these circumstances, the occasional application of a few leeches will often be of considerable service. No counter-irritation, however, ought to be employed in the vicinity of the cancerous part, as it only excites action in and around it, and hastens the process of ulceration; the skin especially is apt to become rapidly infiltrated by the cancerous disease under it, if irritated by the application of iodine and other stimulants. If the tumor be painful, and the skin covering it still unbroken, great relief may be obtained by the application of belladonna plasters. In some cases I have found powdered conium, spread on cotton-wadding, useful in the same way. As it is of importance to prevent, as long as possible, any breach of surface, the application of these sedative plasters and powders should be persevered in with the view of supporting the integument. The local application of ice, so as to freeze the tumor more or less completely, has been recommended of late years by J. Arnott; it may, possibly, in some cases retard the growth or lessen the pain, but there is no evidence to show that it can be considered as a curative agent. When the tumor is ulcerated, the fetor must be diminished by the application of weak solutions of the chlorides, or of Condy's disinfectant, to which opiates may be advantageously added with a view of lessening the pain.

The *curative local treatment* of cancer embraces three methods, viz.: destruction by caustics; absorption by pressure; and removal by the knife. All these local means are employed on one principle, viz: on the supposition that the cancerous tumor which it is proposed to destroy, to absorb, or to extirpate, is primarily a *local* disease: that, if this local malady can be removed sufficiently early, constitutional infection may be prevented; and that, even if this have to some extent taken place, fatal contamination of the system may be retarded by the removal of the local source of that constitutional infection.

The great objection that has been urged against operating in this disease is, that cancer being assumed to be from the first a constitutional affection, it is useless to

remove the local tumor, leaving the constitutional vice unrelieved. If this objection were tenable, it would apply to the removal of cancers in any way, and would have as much force against removing cancerous growth by caustic, by pressure, or by congelation, as by extirpating them by the simpler and speedier means of the knife, and in fact must lead to the conclusion that none but local palliatives are proper in this disease. For such an argument as this to have any value, it must first be shown that cancer is *ab origine* a constitutional affection, and that it is not in the first instance a local disease, which, being allowed to remain unchecked, will at last contaminate and poison the system. The evidence we possess would, however, rather lead us to the opposite conclusion; namely, that cancer is primarily local, and only becomes secondarily constitutional by absorption into the system. This opinion, which Velpeau strongly supports, is founded on the following reasons:—

1. We constantly see cancerous tumors spring up in individuals who have always enjoyed perfect health, and who are to all appearances perfectly well at the time of the occurrence of the disease. As in these cases there is no evidence whatever of constitutional disease of any kind, it would be a begging of the whole question to assert that the existence of the local affection must of itself be taken as an indication of a constitutional cancerous tendency.

2. These tumors are not unfrequently the result of some local injury or irritation.

3. The constitutional health does not, in the majority of cases, suffer until some months have elapsed; when, after the lymphatics or glands have become implicated, or the neighboring tissues invaded, but not until then, signs of cachexy set in.

4. If the disease be removed before neighboring parts have become contaminated, the health, if it have suffered, often improves materially.

5. In the great majority of cases the patient remains free from any recurrence of the disease for some considerable period.

6. In some instances no recurrence whatever takes place, the disease being eradicated from the system, which could not be the case if it were constitutional.

7. When recurrence does take place soon after an operation, it is almost invariably either in the cicatrix or its immediate neighborhood, owing to cancer-cells which had been widely infiltrated escaping removal, and subsequently developing into a new tumor. Were the disease constitutional, recurrence would be as likely to take place in other parts, or in internal organs, as it does when the operation has been too long delayed.

8. We observe the same tendency to recurrence after removal, and even to secondary deposit in distant organs, in other tumors which are incontestably primarily local, such as the fibro-plastic and the enchondromatous, and which only become constitutional in the more advanced stages, and in a secondary manner.

These arguments appear to me to be conclusive as to cancer being primarily a local disease, and only becoming constitutional secondarily by contamination of the blood and absorption into the system, and consequently to justify operation for the removal of cancerous tumors in suitable cases.

Caustics.—The employment of caustics for the destruction of cancers is of old date, and their use has, in all ages and countries, been resorted to by empirics, who profess to remove, by secret remedies less painful and more efficacious than the knife, tumors of a malignant nature. As their application, to use Velpeau's expression, requires neither a knowledge of anatomy nor of operative surgery, they have always been popular with many who have neither the knowledge nor the skill to use the knife. In this country, however, they have never enjoyed any very extended reputation; and in fact they have, perhaps, not been legitimately employed to the extent that they deserve, especially in ulcerated and recurrent cancers, or in those so situated on the skin and muco-cutaneous surfaces as not to admit of being very readily or safely extirpated by operation.

The great objection to the use of caustics has been the severity and the continuance of the pain induced by them, lasting not only for hours, but for days—more intense and prolonged than any occasioned by the knife; and as it is usually necessary, in order to destroy effectually the morbid growth, to repeat the application of the caustic several times, the suffering is often greater than the most resolute patient can submit to.

The chief argument in favor of caustics is the statement that when cancers are thus destroyed, they are less liable to relapse than when extirpated by the knife. There is, however, no positive evidence before the profession in proof of the truth

of this dogma. It is not improbable that the chemical action of the caustics may extend so widely into neighboring tissues as to destroy or render unproductive the cancer-cells by which they are infiltrated, and on the development of which the local recurrence of the disease depends. But it is impossible to believe that the mere method of removal of the local disease can influence the constitutional nature of the cancer. If secondary infection have taken place, it can signify very little whether the local disease be extirpated by the knife or by caustics. If no cachexy exist, it appears to me that the patient must be equally safe in whatever way the local disease is removed, provided it be thoroughly and effectually extirpated. Another advantage urged in favor of caustics, in the correctness of which Velpeau acquiesces is, that enlarged lymphatic glands are more likely to go down under their use than when the primary cancer is extirpated by the knife. Some of the advocates of the use of caustics in the treatment of cancer pretend that the particular agent employed exercises on the morbid structure a specific action, which is confined to it, and does not extend to the neighboring healthy tissues. But this assertion is entirely destitute of foundation.

The caustics that have been and that are employed in the treatment of cancers are very various. They cannot be used indiscriminately, and consequently we must briefly consider them separately.

1. The *concentrated mineral acids*, especially the anhydrous nitric and sulphuric, are often advantageously employed. The concentrated nitric acid may be usefully applied to small superficial cancerous ulcers; it rapidly destroys the tissues, and does not spread too widely, but it is not potent enough for the destruction of tumors. The glacial sulphuric acid, rubbed into a black paste with powdered saffron, is the caustic which Velpeau extols as the most efficient in cancerous tumors, more particularly if of a fungating or bleeding kind. It converts the part to which it is applied into a thick, hard, carbonized eschar, with but little surrounding inflammation; and, as its action is rapid, the pain is not prolonged. On the separation of the hard slough, a healthily granulating cavity will be left, which cicatrizes rapidly with much contraction. It also acts as a hæmostatic, rapidly shrivelling and drying up large bleeding and discharging fungi.

2. The *caustic alkalies*, especially potass and lime, either alone or in combination, in the shape of the Vienna paste, or fused into sticks, are very energetic in their action; but they have the disadvantage of spreading widely if applied to a large surface, and, by softening or dissolving the parts, giving rise to a tendency to hemorrhage. They may, however, be advantageously applied to small cancers of the face.

3. Various *mineral salts*, more particularly the chlorides of antimony, zinc, and bromine, the acid nitrate of mercury, and the arsenious acid, are often employed with much success in the treatment of cancers, ulcers, and growths.

Of the various *chlorides*, that of *zinc* is the most useful. This is applied by being made into a paste with from one to four parts of flour, moistened with a little water, or by the pure chloride slightly moistened being spread on strips of lint. It must, in order to act, be applied to a raw surface; hence it is customary first to destroy the skin with nitric acid, and then to apply the chloride. Canquoin states that a paste, made of equal parts of the chloride and of flour, four lines in thickness, and applied for forty-eight hours, destroys the parts to the depth of one and a half inch. When of less strength and substance, its action is proportionately limited. There are two methods by which a tumor may be attacked and destroyed by caustic paste; either by or from the circumference, or from the centre. When the tumor is large and rapidly growing, it may be most advantageously destroyed from the circumference, at its junction with the healthy tissues. This may be done by the plan adopted by Maisonneuve—of making the paste into small sticks, or pencils, which are pushed deeply and at short intervals into the substance of the tumor around its circumference, so that its tissue becomes penetrated by the action of the caustic in all directions, and its vitality thus rapidly destroyed. In smaller tumors, and those that grow with less rapidity, in which there is no great risk of the rapidity of their growth overtaking and passing beyond the destructive effects of the caustic, the paste may be applied to and around the centre, and the disease in this manner extirpated. In other cases, the tumor may be deeply and rapidly attacked by applying a layer of the chloride of zinc paste over the whole of its surface. The slough produced by this application is then incised, or scored longitudinally at equal dis-

tances of about half an inch, until the parts beneath, to which the caustic has not penetrated, are reached by the incisions so made; pieces of lint covered with the deliquesced chloride are put into them, and afterwards fresh incisions are made until the cauterizing influence has extended to the bottom of the tumor, which finally sloughs out in a mass. Of the utility of the chloride of zinc as a caustic there can be no doubt; but the chief objection to its use lies in the intensity and continuance of the pain occasioned by it. This, however, may be lessened by an admixture of about a sixth part of morphia, or, as L. Parker has suggested, by freezing the part before the caustic is applied, and continuing the application of the frigorific mixture during the time of the action of the caustic. Landolfi has recommended the use of the chloride of bromine in combination with those of gold and zinc; but this caustic does not appear to possess any decided advantage over the simple chloride of zinc, and is objectionable on account of the fumes evolved during its use.

Arsenic exercises a powerful action upon cancerous growths, and constitutes the chief ingredient in many of the secret preparations used by empirics; it is, however, a dangerous agent, and excites great inflammation and pain. If too freely used, it may induce poisoning, and not a few deaths have resulted in this way; it should, accordingly, not be applied at any one time to a surface exceeding a shilling in size. The most convenient mode of applying it appears to be Manec's paste, composed of one part of arsenious acid to eight of cinnabar and four of burnt sponge, rubbed down to a proper consistence with a little water.

Sulphate of zinc, dried, finely levigated, and made into a paste with glycerine, or an ointment with axunge, has been very strongly recommended by Simpson, as one of the most efficient and convenient of all caustics in rodent and cancerous ulcers. In action it somewhat resembles the chloride of zinc, but is less painful.

Of all these caustics, I should certainly say that the deliquesced chloride of zinc is the safest and the most efficacious, more particularly when a scirrhous tumor has to be destroyed. When an encephaloid fungus has to be attacked, the concentrated sulphuric acid is preferable, owing to its coagulating and hæmostatic properties. When small cancerous sores have to be destroyed, the nitric acid, the arsenical paste, or the chloride of zinc, made into a paste with flour and morphia, may very conveniently be used.

Compression is a plan that has been by turns greatly extolled and much depreciated. It was fully tried at the Middlesex Hospital, by Young, forty years ago, and unfavorably reported upon by Sir Charles Bell at that time; it consequently fell into disuse in this country, but was revived by Recamier in France, and employed largely by him. Although he published a favorable account of this practice, it made but little progress amongst French surgeons, the only one who seems to have used it to any extent being Tanchou, who employs a peculiar topical medication conjoined with it. In this country the practice fell into complete oblivion, until J. Arnott, some years ago, invented a mode of employing pressure by means of an elastic air-cushion; since which time it has been pretty extensively employed, with varying degrees of success.

In employing pressure, Young principally had recourse to plasters and bandages. Recamier used amadou applied with an elastic roller; and Tanchou recommends spring pads, under which small bags or pieces of cotton-wadding impregnated with various medicinal substances are placed, so as to protect the skin and act upon the tumor. Arnott's plan consists of pressure exercised by a Macintosh air-bag, held in its place by straps, and pressed upon by a truss-spring, the pressure exercised by which may be made to vary from two-and-a-half to twelve or even sixteen pounds. These different plans should not be employed indiscriminately, but may all be of service in particular cases. I have employed all these methods, but have never found permanent advantage from any of them.

The first question that necessarily arises in reference to the employment of pressure in these cases, is whether it can effect a cure. This it could only be expected to do by producing atrophy, and the subsequent absorption of the strictly local forms of cancer. The only case on record, with any pretension to a conclusive character in this respect, is one related by Walshe in his excellent *Treatise on Cancer*, of the cure of a tumor of the breast, believed to be cancerous, by compression. But even this instance I cannot look upon as by any means conclusive; for, although no one can entertain a higher opinion than I do of the very remarkable diagnostic tact possessed by Dr. Walshe, yet I think there can be no doubt in the mind of any

surgeon that it is absolutely impossible to determine in many cases, by any amount of diagnostic skill, the true nature of a chronic tumor of the breast; and, in fact, we constantly see the most experienced practitioners find, after the removal of the tumor, that it was of a different character from what they had previously anticipated. This difficulty attaches to Walshe's case; and I think that we possess no proof that the tumor of the breast, which underwent absorption under the pressure of Arnott's apparatus, was of a truly cancerous character, and that it might not have been a chronic mammary tumor, or some similar growth, which we know will disappear under this kind of treatment.

But, if compression cannot be shown ever to have cured a cancer, can it not retard the progress of this disease, or relieve the sufferings attendant upon it? I believe that in some cases it may certainly do both, though in others it is as unquestionably injurious. It appears occasionally to retard the growth of the tumor when applied in the early stage, simply by preventing its expansion, and perhaps by compressing its nutrient vessels, and so diminishing the supply of blood sent to it, and by causing absorption of surrounding inflammatory infiltration; in these cases likewise it relieves for a time the pain by lessening the turgescence of the part. In other cases, however, I have known it to act injuriously by pressing out and diffusing the tumor more widely, appearing to increase the tendency to implication of neighboring parts, and occasioning great suffering. When the tumor is ulcerated, or if the skin covering it be inflamed, pressure cannot be employed with any advantage; and most commonly irritable sensitive patients cannot support the constriction of the chest that it induces.

Excision.—With regard to the question of removing cancers by the knife, much difference of opinion exists amongst surgeons; for, though all deprecate indiscriminate recourse to this means, some go so far as to dispute the propriety of ever operating for this disease, whilst others restrict the operation to certain cases of a favorable character. These questions are necessarily of considerable importance, and require attentive examination.

The objections that have been urged against the general propriety of operating in cases of cancer, do not apply so much to the operation itself, the risk attending which is not greater than that of other operations of similar magnitude, but are rather based on the supposition that cancer is originally a constitutional affection, and on the consequent liability of the patient to speedily suffer from a return of the disease, so that an operation that is at least unnecessary will have been performed. This objection, however, as has already been remarked, equally applies to all other means of local removal, as by caustics or compression, as well as to extirpation by the knife; and, if carried to its logical conclusion, must necessarily preclude any attempt at removal, by any means, of the local disease. That this objection, so far as the liability to return of the cancerous disease after operation is concerned, is to some degree a valid one, is undoubted; the experience of all surgeons tending to establish the fact, that the majority of patients operated upon for cancer die eventually, and usually within a limited time, from a recurrence of the disease. Thus, Sir A. Cooper states, that in only nine or ten cases out of a hundred did the disease not return in three years; and Brodie has found that it generally proves fatal in two or three years after the operation.

After removal of the original cancerous tumor, the disease may return in one of three situations, viz: in the cicatrix; in the neighboring lymphatic glands, with or without the cicatrix having been involved; or in internal organs. The mode of recurrence in these different parts is obvious enough. When the disease returns in the *cicatrix*, it is owing to local causes; either to the original cancer having been imperfectly removed, when recurrence will take place before the wound is healed, or very shortly after this event; or it is owing to the widely spread infiltration of cancer-germs through tissues that had a healthy appearance, when recurrence will take place after a lapse of some weeks or months, in the shape either of uniform infiltration of the cicatricial tissue, which assumes the appearance of an elevated hard ridge of a purplish-red color [or of detached nodules], which rapidly coalesce. When it recurs in the *lymphatic glands*, they have doubtless contained the cancer-germs before the removal of the original tumor. They become hard, infiltrated, and often form secondary growths, rivalling the primary disease in size and rapidity of development. When the secondary deposit takes place in *internal organs*, it is usually met with in the liver or the lungs. In such cases it is reasonable to presume

that the cancer-cells have entered the blood, are carried into the general current of the circulation, and are deposited just like the pus-corpuscles* in pyæmia in these organs, where each cancer-germ forms the nucleus of a new growth.

Recurrent cancer, in whatever situation it develop, is more rapid in its course than the primary form of the disease. It may prove fatal in various ways; by exhaustion from local discharges or hemorrhage; by the induction of an anæmic cachexy, in which the nutrition of the system becomes so impaired that death results; or by the induction of internal disease of an acute character, as low pneumonia, pleuritic effusion, or ascites, according as the internal deposit is thoracic or abdominal. The disease is especially apt to recur soon if the skin have become involved, if the lymphatic glands be enlarged, or if there be constitutional cachexy before the operation, so also if the tumor be growing rapidly at the time of removal, and especially if the patient be robust and strong, with a florid complexion.

In determining the question of operating in cases of cancer, several points of great importance present themselves to the consideration of the surgeon. He has first to consider whether the operation is likely to free his patient completely from the affection; or, in the event of its not doing so, whether at least life may not be prolonged by the removal of the cancerous tumor; and, lastly, even though the patient be eventually carried off as speedily as he otherwise would have been, whether his sufferings may not be much lessened by the removal of the local affection.

1. Can cancer be cured, or rather completely extirpated from the system by excision?

That in some cases a cancerous tumor may be removed with every expectation of the patient being completely freed from the disease, cannot, I think, be doubted; although it may be true that such instances are not of frequent occurrence. Yet they occasionally fall under the observation of surgeons, and would certainly tend to prove that the affection is not in all cases of a constitutional character, and that, if we can happily succeed in removing it during its local condition, there is a good prospect that the patient may be rescued from a return of the affection. Velpeau states, that he has perfectly cured patients by the removal of cancerous tumors—at least that no return has taken place for 12, 15, or 20 years after extirpation. The evidence of Sir B. Brodie on this point is extremely valuable; writing in 1846, that eminent surgeon states, that "so long ago as 1832, I removed a breast affected with a scirrhous tumor, and the lady is still in good health—at least, she was so last year. Since the operation she has married, and had children. Last year I was called to see a lady on account of another complaint, on whom I performed the operation thirteen years ago, and found that she continued free from the old disease; and, very lately, I have heard of another lady whose scirrhous breast I removed six years ago, and who continues well." The evidence of Sir W. Fergusson is also very positive on this point, and he speaks in a manner with which I perfectly agree. He says: "Nevertheless, as excision gives the only chance of security—a point on which most parties seem to agree—an operation should always be resorted to, provided the knife can be carried beyond the supposed limits of the disease; and, moreover, I deem it one of the duties of the practitioner to urge the patient to submit to such a proceeding." The opinion of these eminent surgeons, supported as it is by the general practice of the profession, tends to show that in some cases, at least, the disease may be extirpated from the system by excising the tumor before the constitution has become implicated.

2. If cancer cannot be actually cured by excision, may not life be prolonged and health improved by an operation?

I am decidedly of opinion that this is possible; and that, though a patient may at last be carried off by some of the recurrent forms of cancerous disease, health may have been improved, life may have been prolonged, and much suffering may have been spared, by a timely operation. It may often be observed that after the cancer has been removed, the digestion becomes stronger and the patient gains flesh; the color of the complexion returns, and the spirits greatly improve; the system being relieved from a source of local irritation, and the mind from a cause of disquietude that has undermined the general health of the patient. This is more particularly the case in encephaloid cancer, in which early removal of the disease is unquestionably successful, in many cases, in prolonging life. The observations of Paget on this point are peculiarly valuable. He states the average duration of life

* [Or rather, in accordance with Virchow's views, like *embola* (see page 464).—A.]

of those patients laboring under this form of disease, in whom the primary affection is removed, to be about twenty-eight months; whilst the average life of those in whom the disease is allowed to run its course, is scarcely more than two years.

But I think that the introduction of anæsthetic agents into operative surgery has very materially altered the bearings of this important question. So long as an operation was a source of great pain, and of much consequent anxiety and dread, a surgeon might very properly hesitate in subjecting his patient to severe suffering with so doubtful a result; but now that a patient can be freed by a painless procedure from a source of much and constant annoyance, discomfort, and suffering, the surgeon may feel himself justified in thus affording him a few months or years of comparative ease, though he may be fully aware that, at the expiration of that time, the affection may return, and will then certainly prove fatal. Even then, the patient's condition may be much improved; for the recurrent is often less distressing to him than the primary disease, since, as it often takes place in internal organs, it is not attended with the same amount of local pain and distress.

In discussing the propriety of operating in a case of cancer, the surgeon can, however, have little to do with general or abstract considerations. He has to determine what had best be done in the particular case that he is actually considering; and it will serve him little, in coming to a conclusion as to the line of practice that he should adopt, to refer to the statistics of the gross results of operations, or to general comparisons between the results of cases that are not operated upon and those that are. The whole question narrows itself to the point, as to what should best be done in order to prolong the life, or relieve the suffering, of the particular individual whose case is being considered. In order to come to some definite conclusion on this, it is necessary to classify the different cases of cancer, and to arrange them under the heads of those in which no operation is justifiable; those in which the result of any such procedure would be very doubtful; and, those in which an operation is attended with a fair prospect of success.

1. *Cases not admitting of Operation.*—*a.* The operation ought never to be performed in those cases, in which there are several cancerous tumors existing in different parts of the body at the same time. Here the disease is evidently constitutional, and cannot be eradicated by any series of operations. *b.* If the cancerous cachexy be strongly developed, or if the disease be hereditary, it is useless to remove a local affection; as the malignant action will certainly manifest itself elsewhere, or, perhaps, even speedily return in the cicatrix. *c.* If the tumor be of very rapid growth, and be still increasing, there would appear to be so vigorous a local tendency to cancerous deposit, that it will speedily develop itself again in the cicatrix. *d.* If the tumor be so situated that it cannot be completely and entirely extirpated by cutting widely into the surrounding parts, it ought not to be meddled with; otherwise the affection will to a certainty return in the cicatrix before it has closed. It is necessary to remove not only the tumor, but the surrounding tissues to some extent, even though apparently healthy. *e.* If the whole of the affected organ, as a bone, cannot be removed, or if the skin and glands be involved, it is useless to attempt the extirpation of the growth, as a speedy relapse may be confidently looked for. *f.* In the very chronic and indurated cancers of old people, it is often well not to interfere, as in these cases the affection makes such slow progress that it does not appear in any way to shorten life, and the mere operation might be attended with serious risk at an advanced age.

2. *Doubtful Cases.*—Those cases in which the result of an operation is of an extremely doubtful character, but in which no other means offer the slightest prospect of relief to the patient, have next to be considered. *a.* Cancers of the eye, tongue, and of the testes, belong to this category; for, though more liable to return than similar affections of any other part of the body, yet they may be considered fit cases for operation, inasmuch as in no other way has the patient the slightest chance of being relieved from his disease. *b.* In those cancers that are already ulcerated, the surgeon may sometimes operate in order to give the patient ease from present suffering, or, perhaps, as in some cases recorded by Brodie, with a view of prolonging the duration of life; but he can have little expectation of effecting a permanent cure. *c.* If the tumor be of so large a size, or be so situated, that its removal cannot be undertaken without so serious an operation as to occasion in itself considerable risk, the propriety of operating is always very doubtful.

3. *Cases proper for Operation.*—Those cases of cancer in which an operation is, in my opinion, not only perfectly justifiable, but should be urged upon the patient

as affording the best prospect of preserving his life, are those in which the disease has appeared to originate from a strictly local cause in persons otherwise in good health, in whom there is no cachexy or hereditary taint. If the tumor be of a scirrhous character, slow in its progress, single, distinctly circumscribed, without adhesions to or implication of the skin or glands, and more especially if it be attended with much pain, or with immediate risk to life from any cause, and if the whole of the growth, together with a sufficient quantity of the neighboring healthy tissues in which it is imbedded, can be removed with care, the case may be looked upon as a fit one for operation.

In all encephaloid cancers also, early operation should be practised with the view of prolonging life.

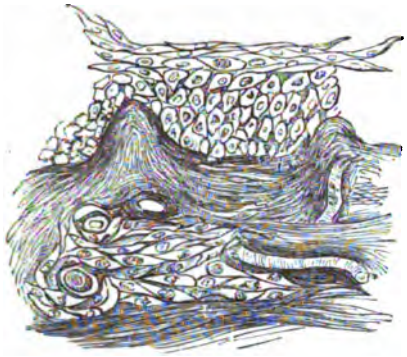
An important question in connection with operations for cancer is, at what period of the growth they may be done with the best prospect of success. Most surgeons, taking a common-sense view of this question, are in favor of removing the affection as early as possible; feeling that, as it is difficult to say when the local form of the disease becomes constitutional, it is safer to remove it as soon as its true nature has been ascertained; and I confess that I can see no advantage that can be gained by delay. The necessity for early operation in *medullary* cancer is admitted by all; but with regard to *scirrhous* cancer the opinion is entertained by some, that in many cases there is a better prospect of success if the operation be delayed; and it is stated by Hervez de Chégoin and Leroy d'Etiolles, that the result of those cases operated on after the cancer has lasted for some time, is more favorable than that of those in which an early operation has been done; the cancer often appearing to be arrested in its development, and to localize itself, as it becomes more chronic, and having consequently a less tendency to speedy return after removal. That the result of operations in such selected cases is favorable, is probable enough; as it may be reasonably supposed that the more active varieties of cancer, those that possess the greatest amount of vegetative activity and of reproductive power, may have acquired a condition unfavorable to operation, or even may have carried off the patient before any period of arrest in their growth has occurred, during which their extirpation could be practised with a fair prospect of success. In delaying operation there is, however, much danger lest valuable time be lost in the employment of means which, ineffective in arresting the disease, may become positively injurious by allowing time to the morbid growth to contaminate the glandular system, or to extend widely through neighboring tissues. If we look upon a cancer as a parasitic growth which must necessarily destroy life, either by changes taking place in its own substance or by the contamination of the system, and which is intractable to all medication, whether topical or constitutional, we must look upon its extirpation as the only resource that surgery offers; and we may assuredly infer, that the liability to constitutional infection and wide-spread local contamination, will be less in proportion to the early removal of the morbid mass.

Epithelioma, though closely allied to the true cancers, differs from them in so many important respects that it requires to be considered as a distinct affection. It resembles the true cancers in its tendency to local infiltration and ulceration, in its extension to the lymphatic system, and in the induction of death by cachexy. It differs from them in its anatomical structure, in being invariably seated in the mucous, muco-cutaneous, and more rarely the cutaneous structures—always on the surface of the body, mucous or cutaneous, where epithelial cells are naturally found, and in its being rarely attended by secondary deposits in the viscera. Some writers have gone so far as to deny any relationship between these growths and the true cancers, and others again have looked upon them as semi-cancerous formations (cancroid of Virchow); there can, however, be little doubt that a true cancer exists, presenting a very marked resemblance to epithelial structures, and that this is perfectly distinct both histologically and clinically from other formations usually grouped together under the title of epithelioma. These are for the most part papillary and glandular developments, and do not present any heterologous structure. In the true epithelial cancer the cells are developed in the substance of the corium, and not upon the free surface; whilst in the other varieties the cells are, primarily at least, developed upon the surface of papillæ, or within gland-tubes, and become only secondarily included in the corium. It is often difficult at a late stage to distinguish these various forms from one another, as they present the same peculiarities of structure.

Situation and Progress.—Epithelioma usually occurs in middle-aged or elderly people; it is generally occasioned by the long-continued or frequently repeated application of some source of irritation, and may thus be established in constitutions otherwise perfectly healthy. Thus, the irritation of a broken tooth upon the tongue or cheek may produce epithelioma of those parts. The scrotum in chimney-sweepers not unfrequently becomes the seat of epithelioma, in consequence of the lodgment and irritation of soot in its rugæ. The muco-cutaneous surfaces are its true habitat; it chiefly occurs in the lips, tongue, mouth, eyelids, penis, vagina, anus, and scrotum. It is, however, also met with in the cutaneous surfaces of the face, the hands, the feet and the scrotum, and, indeed, may occur upon any cutaneous surface, although there can be no doubt that those tubercles and malignant ulcerations that occur in the purely cutaneous surfaces of the extremities and trunk are not unfrequently of a scirrhous character. It commences either as a small flat tubercle or wart, which rapidly ulcerates; or it appears from the first as an intractable ulcer of limited size, with hard and everted edges, and a foul surface. Such an ulcer as this may not only attack and destroy the soft parts in its neighborhood, but may equally produce its destructive action on bones, penetrating deeply into their structure and eroding them. It slowly spreads, and appears at first to be local; but after a time, contaminating the glands in the neighborhood, it induces cachexy, and destroys the patient by exhaustion. Epithelioma, however, is not always superficial; it may develop from deep mucous surfaces. Many of the so-called malignant polypi of the nose—naso-pharyngeal and antral tumors—are of this nature. I have seen an epithelioma as large as a small orange, developing in this situation, and passing into the orbit and to the cheek. In the larynx, pharynx, and œsophagus, the bladder, the uterus, and other organs of this kind, it is also met with. In fact, from any part of the body that is naturally provided with epithelium, and from such surfaces only, epithelioma may be developed. The only apparent exception to its occurrence on the surfaces covered by epithelial or epidermic scales with which I am acquainted, is its appearance as a submucous tumor in the mouth and uterus, of which I have more than once seen instances in both of these situations; the tumors varying in size from a cherry to a small walnut, round, pedunculated, and fibrous looking, but presenting after removal the characteristic epitheliomatous structure. An epithelioma developing upon the integumental surfaces may extend deeply and thus affect or destroy subjacent organs. Thus from the eyelids it may invade and disorganize the eyeball; from the scrotum it may implicate the testis; from the skin it may penetrate into and destroy the subjacent bones, as we see in the face and occasionally in the tibia. Extensive secondary deposits in the lymphatic glands in the vicinity of the parts affected, even deep in the submaxillary, iliac, and pelvic regions, invariably take place after the disease has lasted for some time.

Structure.—On examination, an epithelioma will be found to be composed of a fibrous basis, with a large quantity of condensed and morbid epithelial scales closely packed upon it (Fig. 204). These scales so closely resemble those of the epidermis and epithelium, that they cannot be distinguished from them, but their arrangement is different; they present a remarkably withered appearance, and contain a small and rather shrivelled nucleus; they measure from $\frac{1}{300}$th to $\frac{1}{800}$th or $\frac{1}{1000}$th of an inch in diameter, and are often much flattened (Figs. 205, 206). They are sometimes packed together in masses or balls, assuming a concentric arrangement, hence termed "concentric globes" (Fig. 205), and in these present a somewhat fibrous appearance. According to Simon, however, this fibrous structure is deceptive, depending upon the scales being much attenuated and woven together. These nest-like formations are produced, according to Virchow, by the remarkable tendency to endogenous cell-growth exhibited by some of these cells, and the development of large "brood-spaces" within them: this appears to be due in most cases to the enlargement of the nucleus. The pressure produced by this formation of brood-spaces, and the endogenous cell-growth accompanying it, causes the cells to become flattened and to take on a concentric arrangement. The formation of false nests, which may often be seen in papillary and glandular growths, is due to the development of cells in the limited spaces and to consequent concentric pressure, but never to the enlargement of central cells and consequent excentric pressure. In many cases they are intermixed with globular bodies, and in others with cells of various shapes, resembling those found in the more truly cancerous diseases (Fig. 207). But although the local characters of an epithelioma may

Fig. 204.



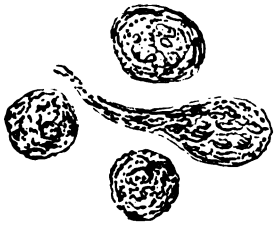
Section of an epithelioma of the cheek, showing the formation of epithelial cells within the substance of the true skin.

Fig. 205.

Cells from epithelial cancer of lower lip.

in some cases be distinguishable with difficulty from those of true cancer, there is a very important pathological difference between the two diseases; for in epithelioma those secondary affections of the viscera which are so common in and characteristic of true cancer rarely occur. When epithelioma proves fatal, it is usually by the progress of the local disease; by its extensive ulcerations; by the contamination of the neighboring lymphatic glands; and by the consequent induction of a constitutional cachexy and malnutrition, with exhaustion of the system. But those

Fig. 206.



Cells from chimney-sweep's cancer.

Fig. 207.

Concentric globes of epithelioma.

secondary tumors which are met with in the liver, lungs, &c., indicative of a deeper contamination of the system than is shown by glandular deposits, and which are the characteristic and almost invariable accompaniment of other forms of cancer, seldom occur in epithelioma.

Diagnosis.—The diagnosis of epithelioma from true cancer is not always easy. The principal points that would guide the surgeon are: 1. The almost invariable occurrence of the epithelioma on the mucous or muco-cutaneous surfaces. 2. Its early ulceration; often from the very commencement, as the primary form of the disease. 3. The tendency to spread by ulceration rather than by new deposit. 4. The origin of the disease from some evident source of external irritation. 5. The absence of all evidence of contamination of internal organs. In making the diagnosis it must be borne in mind that scirrhus, when affecting the mucous or cutaneous surfaces, usually commences as a tubercle; and that, when this ulcerates, the base of the ulcer has a hard and deeply infiltrated feel, extending for some distance into the tissues, whereas epithelioma is never superficial, and is ulcerated rather than tuberculated and infiltrated.

The *prognosis* of epithelioma is far more favorable than that of true cancer in any of its varieties.

Treatment.—The treatment of epithelioma is far more satisfactory than that of the true varieties of carcinomatous disease which we have just been considering, inasmuch as this partakes more of the characters of a local, and less of a constitutional affection, than the true forms of cancer. Constitutional treatment is, I believe, as ineffectual in epithelioma as in the other forms of cancer; but early and free removal by excision or ligature, or complete destruction by caustics, will not uncommonly permanently rid the patient of this affection. Indeed, if the operation be done sufficiently early, I believe there is little liability for the disease to relapse. I am acquainted with several cases in which from six to ten years have elapsed from the date of the operation, without a sign of a tendency to recurrence of the dis-

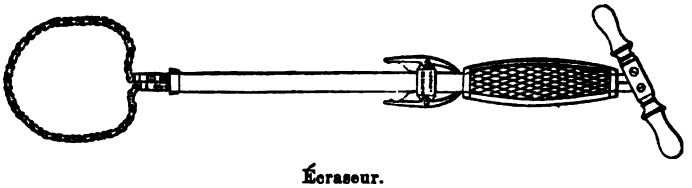
ease. But great risk of recurrence arises from the delay of operation and the employment of inefficient means. The operation may be successfully practised at almost any age. I have removed an epithelioma of the tongue from a man 85 years of age with perfect success.

Excision should always be preferred whenever practicable, and should be done as soon as the nature of the disease is recognized, the part being thoroughly extirpated with a wide margin of tissue on each side of and beneath it, so that no cancer-germs may be left from which new growths can spring. When the neighborboring lymphatic glands are but slightly enlarged, the operation may still be done; the glandular enlargement, which may be dependent on irritation, gradually subsiding. If, however, it be more considerable, the affected gland must be extirpated; but if there be a chain of enlarged glands, more especially in the deeper cavities, no operation should be undertaken, as the disease will then have become constitutional and cannot be fully removed. If the disease be situated on one of the extremities, as the hand or foot, partial or complete amputation may be the safest procedure; and such cases are less liable to relapse than others in which such free extirpation is not admissible.

The *ligature* may be advantageously employed when the cancer is so situated that excision is impracticable, either on account of dangerous hemorrhage, or from the impossibility of effectually extirpating the disease. The part having been well insulated, and effectually strangled by stout whip-cord ligatures, sloughs and separates in a few days.

The *Écraseur.*—A more rapid process of strangulation has been invented by Chassaignac. By means of the *écraseur* (Fig. 208), cancroid and other growths

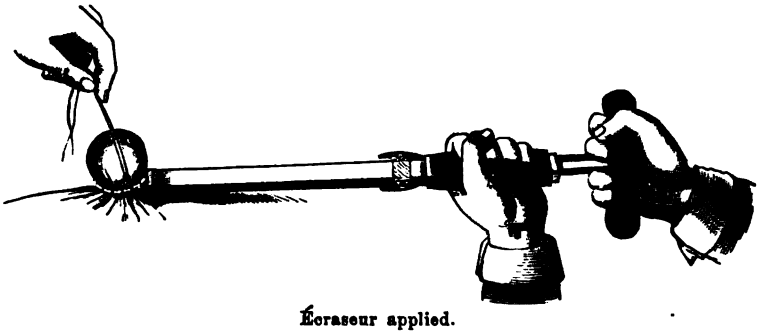
Fig. 208.



Écraseur.

of considerable size are removed with little or no hemorrhage, in the course of a few minutes, by a process of rapid strangulation and crushing in a linear direction. The écraseur consists of a loop of fine steel chain, which, having been passed over the tumor or through the tissues to be removed, is gradually tightened by a mechanism in the stem to which it is attached. In applying this instrument it is often necessary, first of all, to insulate and raise the tumor to be removed by passing a thread through or under it (Fig. 209); and then, having applied the chain's loop

Fig. 209.



Écraseur applied.

round its base, to tighten this and effect the strangulation by working the handle every ten or fifteen seconds, until the mass is detached. The resulting wound is small and puckered in, and often heals with but little trouble. If the mass to be removed be large, two or more écraseurs may be used at the same time, the chains having been passed through the tissues by means of a needle. This instrument

appears to me to be chiefly applicable to cases in which, as in cancroid ulcer of the tongue, excision is hazardous on account of the hemorrhage attending it, while the ligature is objectionable on account of the fetor and discharge resulting from the slow separation of the constricted mass, which sloughs and becomes putrescent. The French surgeons, however, extend the use of the écraseur to many cases in which in this country the ligature or the knife is preferred. They suppose that pyæmia is less likely to follow removal by this instrument than by the more ordinary means, purulent absorption less readily occurring while the vessels on the cut surface are crushed together. Whether this be really so, remains to be proved.

Caustics.—In some instances, the disease being so situated, as in some parts of the face, or in the deeper cavities of the body, that it cannot be dissected out, the application of caustics will be useful in procuring its removal; but, if these agents be employed, care should be taken that they be freely applied and be sufficiently strong, so as thoroughly to destroy the whole of the morbid textures. Inefficient caustics, such as nitrate of silver, irritate and do not destroy the tissues to which they are applied, and in this way do much mischief. Inflammation is excited around the cancroid growths, plastic exudation takes place, and this becomes rapidly infiltrated by the abnormal structure, which thus rapidly extends. The best caustic preparations are the concentrated sulphuric acid, arsenic, and chloride of zinc paste, fused potassa cum calce, the potassa fusa, the Vienna paste, and the acid nitrate of mercury (vide p. 496). All of these may be applied successfully, though they should not be used indiscriminately. The chloride of zinc and the Vienna paste are most useful when the ulcerated surface is large, and indurated at its base or edge. The acid nitrate of mercury should only be employed when the sore is small, superficial, irregular, and without much induration. In such cases also the arsenical pastes and powders already described are very useful.

When a recurrence takes place after operation for epithelioma, it is either by a fresh deposit of cancerous matter in the cicatrix, or else by the neighboring lymphatic glands which had been contaminated before the operation, continuing to enlarge and at last ulcerating, and thus destroying the patient by cachexy and exhaustion, but without the occurrence of secondary deposits in internal organs.

EXCISION OF TUMORS.

In describing the different forms of encysted tumor, the operative procedures necessary for their removal have been adverted to. We may now conveniently consider the steps that are generally necessary for the extirpation by the knife of solid tumors from the soft parts.

In the removal of tumors, the first point to be attended to is the arrangement, shape, and direction of the necessary *incisions*. These should not only have reference to the size of the growth, extending well beyond it at each end, but must also be planned with due regard to subjacent parts of importance. As a general rule they should be carried in the direction of the axis of the limb or part, and parallel to the course of its principal vessels; they must not only extend over the whole length of the tumor, but also a little beyond it at each end: no cross-cuts should be made, if they can be avoided, and this may usually be done by attention to the proper position and extension of the linear incision. In most cases, no skin should be removed, a simple cut being made; but if the integumental tissues be either very abundant and loose, or else adherent, an elliptical portion of them may be excised together with the tumor. In other instances, again, a semilunar flap of integument may with advantage be turned up from the tumor, the surface of which is then fairly exposed; this, however, can only be done in some simple tumors, such as fatty growths. The flaps covering the growth should then be freely but cautiously dissected back, so as to expose its sides and base; as these are approached, and the surgeon reaches the neighborhood of its more important and deeper connections, increased care will be necessary, as it not unfrequently happens that the tumor is in more important relations with deep-seated bloodvessels and nerves of a large size than would at first appear.

When practicable, the *deep dissection* will best be commenced and carried out from that part of the base of the tumor into which the principal bloodvessels appear to enter; they are thus early cut, and being once ligatured give no further trouble, which they would do were they divided from the direction of their branches

towards their trunk, when at each successive stroke of the knife a fresh portion of the vessel would be touched. In carrying on this deep dissection, the operator should proceed methodically from one side of the tumor to the other, the assistants holding aside the skin so as to give as much room as possible, whilst the surgeon himself, seizing the mass with his left hand, or with a large double hook or vulsellum, and dragging it well forwards, uses the knife by successive strokes, but in a leisurely and careful manner, avoiding all undue haste, until he completely detaches it from its connections. The safety of contiguous important structures will be best secured by keeping the edge of the knife constantly directed towards the tumor, if this be of a non-malignant character; by attention to this rule, I have seen Liston remove tumors with remarkable facility and ease from the neighborhood of most important parts. If, however, the growth be of a malignant character, the incisions must be made wide of the disease into the healthy structures around; unless this be done, slices of the tumor may be left from which fresh growths rapidly sprout, or cancer-cells may impregnate the neighboring tissues through which they are scattered, and may eventually become so many fresh centres of malignant action.

After the tumor has been removed, it must be *carefully examined*, with the view of ascertaining whether it is entire; and, if any portions have been left, these must be properly dissected out. In some situations, as the axilla, or side of the neck or groin, where the relations are of great importance, the less the edge of the knife is used the better, and the growth should be enucleated by the surgeon's fingers or by the handle of the scalpel. If it be found that the tumor extends more deeply than had been anticipated, and comes into such close relation with important vessels, as at the summit of the axilla or in the perineum, as to prevent the surgeon from dissecting it out without imminent risk of destroying the patient, the only alternative left is one that I have seen Liston adopt, and have had occasion myself to practise in these situations; viz., to throw a strong whip-cord ligature above the apex of the growth as high up as practicable, and then to cut off everything below this. On the separation of the ligature, any portion of the tumor that has been included will be brought away as if it had been removed by the knife.

In some cases it will be found, after dividing the fascia covering the tumor, that the attachments of the growth are not so firm or deep as had been previously expected; this is especially the case in some large tumors springing from the side of the neck and the parotid region, or in the groin. The growth may then often be removed in a great measure by separating the areolar tissue with the handle of the knife, merely dividing those portions of the deeper attachments that are peculiarly dense. The surgeon should never undertake the removal of tumors that cannot be wholly and entirely extirpated, as the part left will always grow with greatly increased rapidity, often assuming a fungous character; this is especially the case with malignant tumors, the rapidity of increase of which is greatly augmented by partial operations. Should, however, the surgeon have been deceived as to the depth and connections of the mass, and should he find, after commencing his operation, that it is so situated as not to admit of entire removal, he must, in the circumstances, do his best, and cut off or remove by ligature as much of the growth as he can safely expose.

The wound that is left after the removal of a tumor usually unites partly by adhesive inflammation, and partly by the second intention; it should be lightly dressed, the edges being brought together by a few points of suture, with strips of plaster and water-dressing, and if large, supported by a compress and bandage.

CHAPTER XXXV.

SCROFULA AND TUBERCLE.

THESE two diseases are intimately connected with certain morbid states of the lymphatic system, and have by many writers been considered merely as different expressions of the same constitutional state; they may, however, with greater propriety, be viewed as the results of a departure in different directions from the nor-

mal nutrition of the same system of elementary tissues. The two conditions are undoubtedly closely related in their causes and their effects, and may even coexist in the same individual; still, in their most typical forms they present very marked differences, which serve to distinguish them clinically as well as pathologically.

Scrofula.—By this term is meant a peculiar constitutional condition, either hereditary or acquired, that gives rise to chronic inflammatory changes in certain tissues or organs, which are always accompanied by more or less swelling of the proximate lymphatic glands. The affections to which an individual so constituted is most subject, are catarrhal inflammations of the skin and mucous membranes, and subacute inflammations of the periosteal and synovial structures. The products of these inflammatory changes often undergo degeneration and obsolescence, giving rise to cheesy masses, which are not unfrequently confounded with those derived from true tubercle. The constitutional condition that tends to this is sufficiently characteristic; but, although we may recognize its existence, and speak of the individual possessing such a constitution as having a scrofulous tendency or diathesis, he can scarcely be considered to labor under the fully formed disease unless some of the above-mentioned changes have taken place in some of his tissues or organs.

Scrofulous Diathesis.—This is a peculiar constitutional state that is often erroneously confounded with general debility. It may, and often does, coexist with this, but is by no means synonymous with weakness of constitution. Debility often exists without any scrofulous tendency or taint, more particularly in individuals of the nervous temperament; many delicate people, though weak, being perfectly healthy, and showing no disposition to this peculiar affection; on the contrary, the scrofulous constitution is often conjoined with much muscular power and mental activity. But, though no weakness may be manifested in either of these respects, scrofula is invariably conjoined with debility or perversion of the nutritive activity of the body. This is especially manifested in certain tissues, such as the mucous and the cutaneous; and in those organs, the vitality of which is low, as the lymphatic glands, the bones, and the joints. In these, scrofula is especially apt to influence the products of nutrition and of inflammation, more particularly during the early periods of life, when these actions are most energetic, in such a way as to render its existence evident to the surgeon. It is this tendency to the occurrence of particular diseases, and to the engrafting of special characters on affections of certain tissues, that may be considered as specially indicative of the existence of the scrofulous diathesis, the existence of which is, moreover, marked by the presence of a peculiar temperament.

The *scrofulous temperament* assumes two different forms, the fair and the dark, and each of these presents two varieties, the fine and the coarse. The most common is that which occurs in persons with fair, soft, and transparent skin, having clear blue eyes with large pupils, light hair, tapering fingers, and fine white teeth; indeed, whose beauty is often great, especially in early life, being dependent rather on roundness of outline than on grace of form; and whose growth is rapid and precocious. In these individuals the affections are strong, and the procreative powers considerable; the mental activity is also great, and is usually characterized by much delicacy and softness of feeling, and vivacity of intellect. Indeed, it would appear in such persons as these, that the nutritive, procreative, and mental powers are rapidly and energetically developed in early life, but become proportionately early exhausted. In another variety of the fair scrofulous temperament, we find a coarse skin, short and rounded features, light gray eye, crisp and curling sandy hair, a short and somewhat ungainly stature, and clubbed fingers; but not uncommonly, as in the former variety, great and early mental activity, and occasionally much muscular strength.

In the dark form of the scrofulous temperament we usually find a somewhat heavy, sullen, and forbidding appearance; a dark, coarse, sallow, or greasy-looking skin; short, thick, and harsh curly hair; a small stature, but often a powerful and strong-limbed frame, with a certain degree of torpor or languor of the mental faculties, though the powers of the intellect are sometimes remarkably developed. The other dark strumous temperament is characterized by clear dark eyes, fine hair, a sallow skin, and by mental and physical organization that nearly closely resembles the first described variety of the fair strumous diathesis.

In all these varieties of temperament, the digestive organs will be found to be

weak and irritable. This condition, which I believe to be invariably associated with struma, and the importance of which has been pointed out by Sir James Clark, must be regarded as one of the most essential conditions connected with scrofula, and as tending greatly to that impairment of nutrition which is so frequent in this state. This gastric irritability is especially characterized by the tongue, even in young children, being habitually coated towards the root with a thick white fur, through which elongated papillæ project, constituting the "pipped" or "strawberry" tongue; the edges and tip, as well as the lips, being usually of a bright red color. This state of the tongue is aggravated by stimulants, high living, and the habitual use of purgatives. In the fair varieties the bowels are usually somewhat loose, but in the dark forms of struma there is a torpid condition of the intestinal canal. In all cases the action of the heart is feeble, the blood is thin and watery, and there is a tendency to coldness, and often to clamminess of the extremities.

Strumous Inflammation.—One of the most marked characteristics of struma is certainly the peculiar modification that inflammation undergoes, whether we regard the course that it takes, the form that it assumes, its products, or its seat. The course of inflammation in strumous subjects is always slow, feeble, and ill-developed, the more active and sthenic conditions being rarely met with. In its form it is usually congestive, ulcerative, or suppurative; and in its products it is characterized by little tendency to adhesion, by the production of thin, blue, weak, and ill-developed cicatrices, and by the formation of thin, curdy pus, with much shreddy corpuscular lymph.

The seat of strumous inflammation varies greatly; and peculiar modifications of course form, and products are assumed, according to the part that it affects. The tissues implicated by it are chiefly the skin and mucous membranes, the joints, and the bones, occasioning a great variety of special diseases, according as one or other of these structures are affected. It is as the result of, or in connection with these local affections, that the general symptoms of struma become most marked. Whatever the variety of temperament may be, the individual usually emaciates, becomes sallow, cachectic, and debilitated, and at length falls into hectic or marasmus.

Fig. 210.

Scrofulous ulcer of leg.

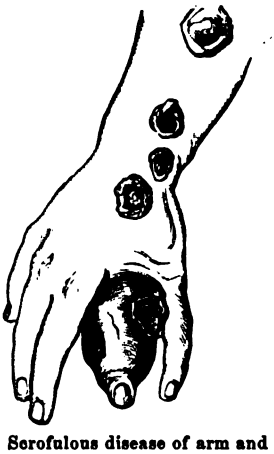
When affecting the *skin*, scrofula declares itself under a variety of cutaneous eruptions, especially the different forms of eczema of the scalp, and various ulcers on the surface, usually weak, and largely granulating, with considerable swelling of the surrounding parts, and a tendency to the formation of thin blue and glazed cicatrices (Fig. 210). The integuments of the whole of the limb may become so much diseased in this way, œdematous, infiltrated, and covered by flabby ulcers and fistulæ, the member being perhaps double its natural size, that amputation is the sole resource. This condition is met with in the arm and foot, and removal of these parts may then be necessary.

The *mucous membranes* are commonly extensively affected, and often present the earlier forms of scrofulous disease in childhood; this is more especially the case with those of the eyelids and nose. The conjunctiva becomes chronically inflamed, perhaps with ulceration of the cornea. The mucous membrane of the eyelids may be permanently congested and irritated, with loss of lashes, constituting the different forms of psorophthalmia. The mucous membrane lining the nostrils becomes chronically congested, red, and swollen, giving rise to habitual sniffing of the nose, and to a sensation as of a constant cold. Occasionally that lining the antrum becomes irritated, and may then occasion an enlargement of this cavity, or the discharge of unhealthy pus into the nostrils. The tonsils are often found chronically enlarged and indurated, with occasional tendency to fresh inflammation; and the larynx may become the seat of various forms of aphonia, dependent on congestion of its lining membrane. The state of the gastro-intestinal mucous membrane has already been described when speaking of the state of the tongue; and that of the genito-urinary organs is also marked by a tendency to debility and irritation, indicated by discharges from the urethra under the influence of very slight exciting causes, and often very per-

manent in their character. The occurrence of calculus of the bladder, especially in children, may also occasionally be attributed to the scrofulous diathesis.

Perhaps the most important local diseases arising under the influence of this agency are those of the *bones and joints*. The bones are liable to the occurrence of various forms of caries and necrosis (Fig. 211); more especially those that are spongy in their texture, as the short bones of the foot, and the articular ends of long bones. The joints are liable to that large class of affections that are commonly included under the term of *white swelling*, which consists of thickening, disorganization, ulceration, and suppuration of the synovial membranes and cartilages.

Fig. 211.



Scrofulous disease of arm and finger.

Lastly, some of the *glandular organs* are peculiarly prone to scrofulous disease. Enlargement of the lymphatic glands, more particularly by the side of the neck and under the angles of the jaw, is of such frequent occurrence, and is usually so early a sign, that the surgeon, in determining whether an individual is scrofulous or not, commonly passes his hand over the glands in this situation in order to ascertain their condition and size; these glandular enlargements are especially apt to run into unhealthy and chronic suppuration. The testes and the mammæ are occasionally affected; but other glandular structures, though sometimes implicated, are by no means so commonly found diseased as those that have just been mentioned.

Tubercle.—The occurrence of tubercle indicates a far greater departure from the normal nutrition of the part than is required for the production of scrofula. The typical constitutional temperament is that described at page 507 as the first scrofulous variety, but every degree will be found to exist between this and the coarser form. Tubercle more frequently affects the serous membranes and the internal organs, especially the areolar tissue entering into their structure, than scrofula does; whilst the skin and mucous membranes, which are so commonly attacked by the latter, are rarely primarily invaded by the former.

Tubercle, though sufficiently well marked by its appearance and progress, cannot be looked upon as a specific affection, but must be considered to be a perverted or unhealthy development of the nutritive materials destined for the repair of the body and the restoration of the blood. According to Simon, it consists of a disease of the lymph, or nascent blood. It is a "dead concretion," a "fibriniform product; insusceptible of development." "The scrofulous diathesis," says Simon, "consists in a peculiarity of blood-development, under which the nascent blood tends to molecular death by superoxydation." According to C. J. B. Williams, "Tubercle is a degraded condition of the nutritive material from which the old textures are renewed,

Fig. 212.

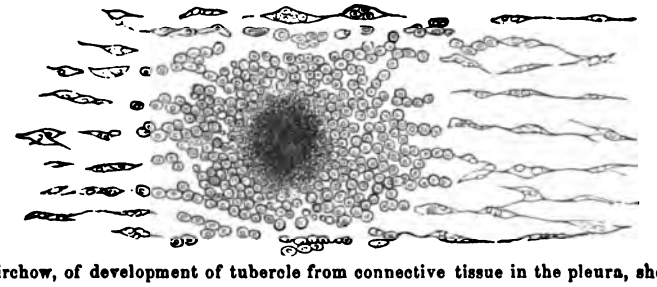


Diagram from Virchow, of development of tubercle from connective tissue in the pleura, showing transition from corpuscles of that tissue up to the production of tubercle granules. The cells in the middle are undergoing fatty degeneration. 300 diameters.

and the new ones formed; and it differs from fibrine or coagulable lymph not in kind, but in degree of vitality and capacity of organization."

It must, however, be viewed in the light of a new formation derived from the

lymphatic elements of the connective tissue (Fig. 212), and it exhibits a constant tendency to affect the lymphatic system in every organ which it invades. It is essentially a lowly organized formation, tending rapidly to disintegration and dissolution. Recent experiments have confirmed the opinion formerly held, that it has not a specific origin: it may be produced in the lower animals by the introduction beneath the skin of irritating or putrid animal substances, and it will very readily reproduce itself, both locally and in internal organs, when transferred from one animal to another.

Structure.—Tubercle essentially occurs in two forms. It is met with as semi-transparent gray granulations, smooth, and cartilaginous in look, somewhat hard, closely adherent, and accumulated in groups, often with a good deal of inflammatory action in the surrounding tissues. These gray granulations, usually about the size of a small pin's head, appear to consist of modified exudation matter. They have a tendency to run into masses, and to form the true yellow tubercle, which is met with in opaque, firm, but friable concretions of a dull whitish, or yellowish color, homogeneous in structure, and without any appearance of vascularity.

The microscopic characters of tubercle present no very specific appearances. The gray granulations or miliary tubercle consist mainly of a firm, homogeneous stroma, in which are imbedded a number of cells and nuclei. These cells present two principal varieties, which measure respectively $\frac{1}{1500}$th to $\frac{1}{1800}$th of an inch in diameter: the larger ones contain two or three nuclei, which may sometimes be seen in the act of dividing; the smaller ones contain only a single nucleus. Many free nuclei also exist, oval or spindle-shaped.

In the condition called crude yellow tubercle, multiple cells may be found at the circumference of the mass, whilst single nucleated cells occupy the centre: free nuclei are scattered abundantly amongst the cells. Both cells and nuclei present a remarkably shrivelled, irregular, and granular appearance, which was formerly considered as their great characteristic. The cells measure from $\frac{1}{2000}$th to $\frac{1}{3000}$th of an inch in diameter. In the softer forms of yellow tubercle the cells are more disintegrated, and drops of molecular oil and much granular matter are present. The fluid parts may subsequently become absorbed, and leave a cheesy or cretaceous mass. Tubercle must often be recognized rather by its negative than by its positive characters—by ascertaining what it is not; and so, by a process of exclusion, arriving at its true nature. It is most easily confounded with pus, from which, however, it may be distinguished by its possessing a solid intercellular substance.

The *progress* of tubercle is most commonly to disintegration and liquefaction, at the same time that it gives rise, by its irritation, to inflammation and suppuration in the surrounding tissues; hence it commonly leads to abscesses, the pus of which is always curdy and shreddy. In some cases, tubercle may become indurated, and undergo a species of calcification.

Causes.—The causes of scrofula and tubercle, unless these be of a hereditary character, though very various in their nature, are usually such conditions as influence injuriously the nutrition of the body.

The *hereditary nature* of both scrofula and tubercle is well known to the public and to the profession; for, although the disease is not commonly connate, yet the tendency to it is, and the characteristic nature of the affection often manifests itself at an early period notwithstanding every effort to prevent its development. That a parent may develop a tendency to malnutrition, to misdevelopment of the blood, just as he may a peculiar feature or mental condition, is undoubted. It is by the hereditary transmission of peculiar combinations and modifications of action in the organization that hereditary diseases develop themselves at certain periods in the life of the offspring, when the injurious results of the morbid actions that have been transmitted have had time to be produced. There are certain conditions which, though not scrofulous, are supposed to have a tendency to develop this disease in the offspring to which they are transmitted; thus very dyspeptic parents commonly have strumous children; so, also, the offspring of very old or very young people often exhibit a proneness to scrofulous or tuberculous affections. The influence of intermarriage is still a matter of doubt, but I believe that it exercises little influence in this respect; and it is commonly stated that the inhabitants of small communities who intermarry closely, such as those of the Isles of Portland and of Man, are not more liable to scrofula than other individuals.

The most powerful occasioning cause of scrofula, and that which in most civi-

lized countries is likewise the most frequent, is *malnutrition* and *malassimilation* arising from an habitual disregard of hygienic laws; either from want of food, or the administration of improper food, in the poorer classes; or from overfeeding, and overstimulation of the digestive organs, amongst the children of the wealthier orders of society, inducing chronic irritation of the mucous membrane of the stomach, and interference with the digestive powers, and consequently with nutrition. The influence of food that is innutritious in quality or insufficient in quantity, has been shown by Phillips, in his excellent *Treatise on Scrofula*, to be the most immediate cause of this disease; and, when conjoined with the injurious effects of a confined and impure atmosphere, it may be considered as sufficient to occasion the disease in those cases in which no predisposition to it exists, and greatly to develop any hereditary tendency to it in the system. It is to the conjoined influence of agencies such as these, that we must attribute the prevalence of scrofula amongst the lower orders both of town and of rural populations.

Both scrofula and tubercle are often called into immediate action by the *debility induced by previous diseases*, such as measles, scarlatina, hooping-cough, &c., which lead to an overaction of the lymphatic system, resulting in an active hyperplasia of the gland-elements. The former usually develops itself at *an early age*, though seldom before the child has reached its second year. It is most commonly about the period of the second dentition that the affection declares itself, and it is rare to meet with it for the first time after the ages of twenty-five or thirty-five. According to Phillips, when it is fatal it usually proves so before the fifteenth year; 60 to 70 per cent. of the deaths occurring before this age. *Sex* does not appear materially to influence the disease; though, according to the same authority, the deaths of males from scrofula exceed those of females, in this country, by 24 per cent. These numbers may, however, require correction if we are to regard phthisis as an affection dependent upon the existence of either of these conditions, people who are scrofulous in early life often becoming the subjects of that form of phthisis now called scrofulous pneumonia.

Treatment.—This should rather consist in endeavoring to prevent the occurrence or full manifestation of scrofula, than in removing it when it is actually existing. Indeed, the *preventive treatment* is perhaps of most consequence, and by proper attention to it, I have no hesitation in saying, the development of the affection, even when hereditary, may be stopped; and the child of strumous parents, presenting perhaps the features indicative of the diathesis, may pass through life without the disease having an opportunity of declaring itself. In order to accomplish this, however, the preventive plan of treatment must be commenced early, and continued uninterruptedly for a considerable time, even for years.

The preventive treatment of scrofula and tubercle may be said in general terms to consist in close and continuous attention to hygienic rules. The diet must be especially attended to; nourishing food, but of the lightest quality, being given. A great error is often committed in overloading the stomach with more or with heavier food than it can digest, under the impression that strong food is necessary to give the patient strength. In consequence of this error, the irritability of the mucous membrane is kept up, nutrition is imperfectly and badly performed, the surplus food is thrown off in the shape of lithates or other products of malassimilation, and health and strength, which are the results of perfect nutrition, become impaired rather than improved. The use of stimulants, whether wine or beer, should be very sparing, and the milder and weaker should be preferred to the heavier and stronger kinds of malt liquor; the bowels must be kept regular with the simplest aperients; the clothing should be warm, and must cover the whole of the surface; and the patient should, if possible, be kept in well-ventilated rooms. He should be allowed sufficient exercise in the open air, not carried to the point of fatigue, and should, if his circumstances will permit, have change of air from time to time, alternating a sea with an inland climate. Bathing also, whether in sea or river, with the habitual use of the tepid or cold sponge-bath, and friction of the surface with horse-hair gloves or a rough towel, so as to keep the skin in healthy action and its cutaneous circulation free, should be regularly practised.

The *curative treatment* should be specially directed, like the preventive, to the general improvement of the nutrition, and through it to the augmentation of the constitutional vigor of the patient; all those hygienic means that have just been alluded to being continuously carried out.

The more strictly medical treatment of scrofula consists in the administration of tonics and alteratives with the view of improving the patient's constitutional powers. Before they are administered, however, it is always necessary to see that the digestive organs are in a healthy condition. Scrofula is a consequence of malnutrition; and unless we see that digestion, the first stage of the nutritive process, is properly accomplished, all other means will be useless. When the tongue is covered with a white, thick, creamy fur, and has elongated papillæ and red edges, the mucous membrane being in a state partly of irritability and partly of debility, neither purgatives nor tonics can be largely administered: the former irritating, the latter overstimulating the morbidly sensitive mucous membrane. In these circumstances the patient should be confined to the mildest possible diet, which must principally consist of milk, boiled fish, white meats, and light pudding, no stimulant of any kind being allowed except a small quantity of claret or bitter beer; and, unless the patient have been accustomed to the use of stimulants, these even had better be dispensed with. Small doses of mercury with chalk, of soda and rhubarb, should be occasionally administered at bedtime, with some of the compound decoction of aloes on the following morning, and a few grains of the carbonate of soda or of potass may be given twice or thrice a day in some light bitter infusion, as of cascarilla or calumba. In many cases of strumous disease, more especially those affecting the joints and bones, the liver will be found to be enlarged and sluggish in its action, the patient every now and then becoming bilious, sallow, and jaundiced; in these circumstances, small doses of blue pill, carried off with the compound decoction of aloes or a rhubarb draught, will be found necessary from time to time. When all gastric irritation has been removed in this way, or if it have not existed in the usual marked degree from the first, the patient being pale and flabby, with a weakened condition of the pulse, of the skin, and of the mucous surface, then tonics may be administered, and the more specific treatment adopted.

The great remedies which are employed with the view of removing scrofula and curing the secondary affections which it induces, are iron, iodine, the preparations of potass, and cod-liver oil. These are all extremely useful, either singly or conjoined, as they serve to carry out distinct indications in the management of this affection.

Iron is most useful in improving the nutrition of pale, flabby, anæmic subjects, increasing markedly the quantity and quality of blood in the system. The best preparations for children are, I think, the vinum ferri and the iodide. In older persons the tincture of the sesquichloride, and some of the forms of the citrate or the phosphate of iron, appear to be most serviceable; in other cases, again, the natural chalybeate waters will be found to agree best.

Iodine is especially valuable in promoting the absorption of effused plastic matters, and in lessening the morbid hypertrophies which so commonly take place in scrofula. The preparation usually employed is the iodide of potassium. In order that this may produce its full effects, it should be given as freely as the patient will bear it, continued for a considerable length of time, and especially administered in combination with other preparations of potass. With the view of preventing it from irritating the stomach, it should be given in a considerable quantity of some bland fluid. Its combination with the other salts renders it more efficacious in removing strumous enlargements and deposits of aplastic and tuberculous matter. For this purpose I have found the following form extremely useful for adults, the dose being proportionately diminished in the case of children: ℞. Potassii iodidi, Potassæ chloratis, āā ʒj; Potassæ bicarbonatis, ʒiij. Divide into twelve powders, of which one is to be taken night and morning in half a pint of warm milk.

In other cases, the liquor potassæ, Brandish's alkaline solution, or lime-water given freely in milk, are serviceable; but I prefer the above prescription.

Cod-liver oil, which may be looked upon rather as an article of diet than as a medicine, is of essential utility in improving the nutrition of the body in cachectic and emaciated states of the system, more particularly in growing children, or in individuals who are suffering from the wasting effects of strumous suppuration; it not only fattens but strengthens the system, increasing decidedly the muscular power and the quantity of red corpuscles in the blood. It may often very advantageously be administered in combination with the iodides of potassium or of iron.

Of the other tonic remedies which may be employed in this affection, such as the

preparations of *bark* and of *sarsaparilla*, I need say nothing beyond that they may often be usefully administered in fulfilling ordinary therapeutic indications.

The *local treatment* of scrofula consists in a great measure in the ordinary local management of chronic inflammation, modified according to the seat and particular nature of the affection. Much of the local treatment, however, especially in the more advanced stages, consists in removing the effects of the disease in the shape of aplastic deposits, false hypertrophies, and general enlargement and thickening of parts. This may usually be done by the application of lotions containing the iodide of potassium, or the carbonate of potass, applied by means of lint covered with oiled silk; a drachm of each of the salts, with an ounce of spirits of wine to eleven ounces of water, makes an excellent application, which appears to dissolve away the fibrinous and plastic deposits so common in this disease. In many cases, frictions with the iodide of lead ointment, or pressure by means of strapping and bandages, will be found the most serviceable means that the surgeon can adopt. When matter forms, it should be let out in accordance with the rules laid down in treating of the more chronic forms of abscess. In these cases, the injection of the sac of the abscess with a solution of iodine will be found very useful.

Operations in Scrofulous and Tuberculous Cases.—In cases of scrofulous disease of the soft parts, the bones, or the joints, the question of the propriety of operating, whether this be for the excision of a gland, the resection of a joint or bone, or the amputation of a limb, has often been discussed. In these cases, operations should not, I think, be undertaken too hastily, too early in the disease, or especially in very young subjects. The affection being a constitutional one, it will often be found, as the general health of the patient improves by proper treatment, that local mischief, which at first appeared of a very intractable character, gradually assumes a more circumscribed and healthy form, and, in fact, to a great extent undergoes spontaneous cure by the restoration of the healthy action in the parts. This we especially find to be the case in young children, in whom very extensive disease of the bones and joints may often be recovered from, without the necessity of any serious surgical interference. Should any operation be undertaken, it is desirable not to have recourse to it whilst the disease is actively spreading. In these circumstances, it is not only probable that suppurative inflammation of an unhealthy kind may be set up in the wound itself, but that disease of the soft parts or bones may very likely recur in the cicatrix of the original wound, or that the corresponding parts on the opposite side of the body may become similarly affected in very chronic cases of scrofulous disease of bones and joints. I have several times observed, after excision of the elbow, the knee, or the bones of the foot and wrist, that the morbid action has returned in the contiguous soft parts to such an extent as to render a second operation necessary, although the bones were not implicated; the tissues in the neighborhood of the cicatrix becoming swollen, spongy, and infiltrated with a quantity of gelatinous semi-transparent plastic matter, running into unhealthy suppuration, with fistulous tracts leading through it that could not be brought to heal. In some cases even of simple strumous disease of the integuments of the arm, leg, or foot, attended with great and irregular deposition of plastic matter, and chronic and intractable ulceration, amputation of the limb is the only course left to the surgeon. When strumous suppuration leads to hectic, the patient will speedily sink unless the diseased structures be removed.

CHAPTER XXXVI.

VENEREAL DISEASES.

The term *venereal disease* is used to denote those affections which arise primarily from sexual intercourse. It was, until lately, held to include two distinct specific diseases—Syphilis and Gonorrhœa: and this division was followed in the previous editions of this book. The special researches of surgeons in this country and on the continent have, however, in late years apparently established the fact, that in

the term Syphilis there have been included two distinct affections, both communicable by contagion during intercourse, but differing in their characters, and especially in this—that the one is purely a local affection, while the other not only produces local effects, but, by the introduction of a specific poison into the system, infects the general constitution of the person to whom it is communicated. To the purely local disease, the term local contagious ulcer or chancre may be applied; the word Syphilis being restricted to the constitutional affection.

Hunter and his followers supposed that all the specific diseases arising from sexual intercourse originated from one and the same poison. But this doctrine has been proved to be erroneous; for not only are the local appearances and constitutional effects of these diseases widely different, but Ricord has shown, in the most conclusive manner, that gonorrhœal matter, when inoculated on the skin or mucous membrane, never produces a chancre; and that, on the other hand, chancrous pus can never be made to produce gonorrhœa. Each of the diseases—local contagious chancre, syphilis, and gonorrhœa—propagates itself, and no other. Two of these diseases may, however, coexist in the same person. Thus, we shall have occasion to notice the coincidence, in some cases, of the local chancre with the phenomena of constitutional syphilis. Again, Ricord has pointed out, that a woman may at the same time be affected by gonorrhœa and by chancres on the uterus; and this probably explains those cases in which, after connection with the same woman, different men have contracted different forms of disease, or even both affections. In this chapter, we shall describe—1, the local contagious ulcer or chancre; 2, syphilis, or constitutional syphilis; reserving the consideration of gonorrhœa till we speak of diseases of the urinary organs.

I.—LOCAL CONTAGIOUS ULCER OR CHANCRE.

The *local contagious ulcer* consists of sores of special forms and appearance, characteristic of the nature of the disease; they may occur on the cutaneous, the muco-cutaneous, and mucous surfaces, most commonly on the latter, on account partly of their greater exposure to contagion, but chiefly from their being less perfectly protected by epidermis.

These local specific ulcers or *chancres* present much variety as to their appearance, and to the course which they pursue: so great indeed are the varieties, that they have been looked upon by some surgeons as affording evidence of distinct diseases proceeding from different poisons. This doctrine, however, is entirely erroneous; the varieties in their appearance depend on seat, constitution, and other accidental circumstances. A chancre, then, is a specific venereal sore or ulcer, originating invariably from contagion, and capable of propagation to other parts of the same or of different individuals by inoculation. Like all other ulcers, a chancre presents two distinct periods; the first, in which it is either spreading or stationary, in which alone it is specific, and which may be of almost indefinite duration; and the second, in which it has commenced to granulate, and a process of repair is set up in it.[1]

Specific Nature.—Ricord has made the important observation that, if the pus from a chancre, during its first period, be inoculated into any part of the surface of the body, it will invariably produce another specific venereal sore or chancre; and that no pus that is not chancrous can, under any circumstances, occasion the specific venereal ulcer. This inoculable ulcer is always in its effects a local disease, being confined to a specific sore; of which the furthest complications are repetition of the sore wherever its discharge invades an unprotected surface, and the occasional irritation of the neighboring lymphatic glands to inflammation and abscess.

Origin and Progress.—A chancre is necessarily generally contracted in impure sexual intercourse with a person already contaminated by the disease, by the direct contact of the healthy with a previously diseased surface. When a chancre is caught in connection, it usually commences with a small excoriation, which appears to have been directly inoculated with the specific poison. In other cases, again, though more rarely, it may be seen at first in the shape of a small pointed pustule,

[1] The term chancre is also applied to the ulcer which is the primary manifestation of constitutional syphilis. This chancre, which presents distinctive characters, will be found described at page 525.

which speedily breaks, leaving an ulcer of a specific character in its site. Very generally, however, this pustule escapes observation, and the disease is presented in the first instance as an ulcer. The chancrous ulcer, whatever form it assumes, seldom makes its appearance until a few days (five or six) after connection. In some cases, however, I have observed it, evidently from the infection of a fissure or crack, on the day following impure intercourse; and occasionally, in rare instances, its appearance may be delayed a few days longer than that time which has been mentioned.

Chancres are occasionally contracted in various irregular ways. Thus they may occur on the fingers of surgeons or accoucheurs from dressing venereal sores, or from attending diseased women during labor. In these instances, however, the consequences of contagion are nearly always of another kind; namely, the inoculation of constitutional syphilis, not the merely local ulcer. In other cases, the disorder is contracted from the contact of filthy clothes or dirty utensils with the person; and not uncommonly, it is said, chancres are contracted at public water-closets. Although the latter mode of infection is not impossible, it should be received with doubt, as it is an explanation not uncommonly adopted by those who desire to account for the consequences of an act of immorality, in a way that does not expose them to reproof.

Whatever be the appearances presented by a chancre, there can no longer be any doubt that the disease arises from one kind of virus only; the modifications in the sore depending on its situation, on the constitution of the patient, and occasionally on that of the individual who communicates the infection. That this is so, is evident from the fact that every chancre, when inoculated, reverts to one typical form; and that, however much chancres may ultimately differ, they all present the same characters during their early stages.

The progress of a chancre that has been artificially inoculated on any part of the cutaneous surface is as follows, and its study will serve to elucidate what takes place in other circumstances. During the first twenty-four hours after the introduction of the specific pus into the skin on the point of a lancet, we find that some inflammation is set up around the puncture, which becomes hot, red, and itchy. About the third or fourth day, a pointed pustule is produced, which is at first deep-set, but becomes on the following day more superficial, with some depression in the centre, resembling rather closely a smallpox pustule; on close examination, this will be found not to be a true pustule, but rather a mass of epithelial scales and pus not included in a distinct wall. On the fifth day, it has become hard at the base, apparently from the infiltration of plastic matter; and on the sixth it has usually dried, forming a small round scab, and leaving an ulcer which presents the typical characters of a true chancre, being circular and depressed, with a foul grayish surface which cannot be cleansed, sharp-cut edges, a hard base, and an angry-looking red areola around it. This is the typical chancre, and these are the appearances that every true venereal non-syphilitic sore on the skin will present about the fifth or sixth day after inoculation; from this time it may diverge more or less completely from these characters, but will yet, if inoculated at any time during the poisonous stage, produce an ulcer that will run the specific course up to the same period, after which it may in its turn again deviate into one or other of the unusual forms that chancres occasionally assume.

Varieties.—These have been described under various denominations by the numerous writers on these affections. The following classification will include them all: 1, the simple or soft chancre, or chancrous excoriation; 2, the phagedænic chancre; and 3, the sloughing chancre. As H. Lee has observed, each of these varieties of chancre is associated with a particular variety of inflammatory action. Thus the *soft* is the *suppurative* form; the *phagedænic*, the *ulcerative;* and the *sloughing*, the *gangrenous*. The particular form of the sore is in each case determined by its situation, and the constitution of the patient or that of the individual furnishing the contagion.

1. *Simple or soft chancre*, or *chancrous excoriation*, is certainly that form of the disease which is most commonly met with in London at present, from its excessively contagious character. It consists of one or more small sores, of a very shallow character, resembling rather an abrasion, with sharp-cut edges, somewhat circular in shape, and having a tawny grayish or yellowish surface, with a narrow red areola around the edge: in many cases attended with much heat and itching. These sores

are usually seated on the cleft under the corona glandis, or about the glans, the whole of which may be studded by them. In fact, one peculiarity of this chancre is its tendency to multiplication on the contiguous structures. In other cases, the sores invade the frænum, which may be perforated; or they may occupy the mucous surface of the prepuce. In no cases are they indurated.

The excoriated chancres not unfrequently present somewhat varying appearances. In some cases their surface becomes covered with large fungous granulations, hence termed *fungating sores*. In other instances they are truly irritable, becoming exceedingly sensitive, with a tendency to spread, and having an areola of a dusky red hue around them. It very frequently happens that these chancres are attended by much general inflammation of the penis; the organ being swollen, red, and semi-transparent, from subcutaneous œdema, and usually in a state of phimosis, with much purulent secretion between the prepuce and glans.

2. *Phagedænic chancre* is characterized by a tendency to erosion, with much destruction of the parts that it invades. It may assume the phagedænic character from the very first, or this may be set up in one of the other varieties of chancre at some period of their course. The progress of this phagedænic or eroding chancre is usually somewhat slow, but continuous; it commonly affects the glans, more especially in the neighborhood of the frænum or urethra, destroying a considerable portion of the organ in this situation. Wallace has divided this form of chancre into three varieties: that *without slough*, that *with white slough*, and that *with black slough*. Each of these varieties, again, may be of a *simple*, an *inflamed*, or an *irritable* character. This classification appears to me to be a useful and practical one, and I accordingly adopt it.

The *phagedænic chancre without slough* is a truly eroding ulcer, spreading with sharply cut edges, attended by some slight inflammatory action, and with much activity of progress; it is commonly observed about the frænum and under part of the glans, and very frequently hollows out and destroys the organ in this situation to a considerable extent.

In the *phagedænic chancre with white slough*, we find an irregular eroding ulcer, with a thin margin of white slough situated at the junction of the dead and living structures; that which covers the surface of the sore having usually become darkened by exposure to air, to dressings, and to secretions.

The *phagedænic chancre with black slough* differs but little from the last, except in the color of the slough, which may be in a great measure accidental, and in its tendency to induration, and to somewhat rapid extension; it must not be confounded with the next form of chancre, which presents many points of difference. All these varieties of phagedænic chancre may be inflamed, being attended by much heat, redness, and swelling, increase of discharge, and rapidity of action; or they may be irritable, occurring in cachectic individuals, when they are accompanied by much pain, and usually a good deal of constitutional disturbance of a nervous and irritative type.

3. *Sloughing chancre*, or *gangrenous phagedæna*, is a combination of rapidly spreading and destructive gangrene with the venereal poison, and may be looked upon as a gangrenous inflammation of a venereal sore.

The gangrenous action is usually the consequence of the confinement of the venereal pus under an elongated prepuce, in a person of inflammatory and irritable constitution, in whom the loose areolar tissue of the genital organs readily takes on sloughing action when inflamed. It usually affects the upper surface of the prepuce. The parts becoming immensely swollen, red, and somewhat brawny, and the prepuce being in a state of complete and permanent phimosis, a dusky black-looking spot soon makes its appearance on one side of the organ; this rapidly extends, giving rise to thick, black, soft, and pultaceous sloughs, destroying perhaps the whole of the prepuce, and exposing and implicating the glans to a great extent, accompanied sometimes by copious hemorrhage from the dorsal artery of the penis on the separation of the sloughs, and by denudation of the corpora cavernosa. In other cases, the prepuce sloughs on one side only; a round aperture forming in it, through which the glans projects, whilst the swollen and inflamed extremity of the prepuce hangs down behind it, giving the organ a very remarkable, and, at first sight, somewhat puzzling appearance. After the separation of the sloughs, granulations rapidly spring up, the sore loses its specific character, and cicatrization advances with rapidity.

Situation.—As chancres almost invariably result from connection with persons suffering from sores of similar nature, they commonly occur on the genital organs. In the *male* they may be met with in any part of these; their characters vary somewhat, however, according to the situation in which they occur. They are by far most commonly seated in the angle formed between the glans and the prepuce; they then appear most frequently at the orifice or on the inner surface of the prepuce, next on the frænum, then on the glans, and lastly at the orifice of the urethra, or on the skin of the body of the penis. Those about the frænum are often sloughy and irritable, have a great tendency to perforate or destroy this membrane, and are more frequently followed by hemorrhage or bubo than any of the other varieties of the disease.

The *urethral chancre* is usually situated just within the orifice of the canal, and may be seen on pressing open its lips, in the form of a small sloughy sore, which occasionally creeps out upon the glans. Sometimes it is more deeply seated, so as to be out of sight; when this is the case, a thick, tenacious, sloughy and bloody discharge appears in small quantities from the urethra; at a little distance up the canal there will usually be felt, on grasping the organ between the fingers, a circumscribed indurated spot, which is somewhat painful on pressure and after micturition. The chancres have been found by Ricord to extend along the whole of the urethra, even to the bladder; and it is their presence in this canal that formerly led to the supposition of the identity of syphilis and gonorrhœa, an error the nature of which has been cleared up by the test of inoculation; the discharge from urethral chancre producing the typical sore, that from gonorrhœa giving no result when introduced under the skin. The existence of chancre within the urethra may be suspected if the surgeon observe that the urethral discharge is small in quantity, and somewhat dark colored, ichorous, and sloughy in appearance. The chancre may be detected by everting the edges of the urethra, or, if situated too high up the canal to be seen, by being felt hard and nodulated through its coats.

Chancres may also form on other parts where they have been accidentally or purposely inoculated. Thus I saw many years ago (1839) in Ricord's wards, a man, laboring under *eczema of the legs*, in whom the cutaneous disease had been converted into a series of immense chancres by accidental inoculation from a sore on the penis.

In *women*, chancres are usually situated on the external organs of generation, most usually just inside the fourchette or labia minora, very rarely indeed on the lining membrane of the vagina, but sometimes on the cervix or os uteri; hence it is impossible ever to pronounce a woman free from chancre without examining these parts by means of the speculum. When situated upon the external organs, they are not unfrequently concealed between the rugæ, or in nooks and corners of the mucous membrane. In these cases, their presence may sometimes be detected by the labia being swollen and œdematous from the irritation produced by them.

Diagnosis.—The diagnosis of chancre is usually sufficiently easy, the peculiar character of the sore enabling the surgeon to recognize it in all its forms. In some instances, however, it is by no means easy to say positively whether an ulcer on the penis be or be not chancrous. It is especially difficult to distinguish some forms of excoriated chancre from herpes or aphthæ on the prepuce or glans, or from those slight excoriations that many men habitually contract after a somewhat impure connection; so, also, the wound resulting from a ruptured frænum often presents a suspicious appearance. In these cases, however, the absence of any specific character about the sore, its immediate occurrence after connection, the general known tendency of the patient to these affections, and the fact of the inguinal glands not being generally indolently enlarged, will enable the surgeon to diagnose the ulcer to be simply a local affection, and not the prelude to general syphilitic eruptions. When the prepuce is in a state of inflammatory phimosis, it is always extremely difficult to determine by mere examination whether there be chancres under it or not, though their indurated bases may sometimes be felt through it. In the case of the phagedænic or the sloughy chancre, there can be little difficulty is establishing the true nature of the affection. In those cases in which a comparison of the characters of the sore with one or other of the different recognized varieties of chancre failed in enabling the surgeon to determine the true nature of the affection, it was thought at one time, when the local contagious ulcer and the phenomena attending the progress of syphilis were confounded together, that the influence exercised by

mercury upon the sore would determine whether the disease were syphilitic or not; the true chancres being supposed to be curable in no other way than by the internal administration of mercury; but, although there can be no doubt that the influence exercised by treatment assists the surgeon considerably in the diagnosis of obscure cases, yet it cannot be relied upon as a test of the nature of the disease, many venereal affections being readily curable by very simple means without mercury. It must be further recollected, that little practical advantage is gained by experimenting on the contagious quality of the discharge; because, if the patient have been exposed to syphilitic contagion, when the sore comes under the observation of the surgeon it will be impossible to prevent his infection, which will have taken place in a very few hours after the application of the poison.

Treatment of Chancre.—The treatment of venereal sores has engaged the anxious attention of the most eminent surgeons; and so much difference of opinion and practice regarding it still prevails, that I shall not endeavor to discuss the subject generally, but rather confine my remarks upon it to that form of treatment which has met with the sanction of the best surgeons in this country, and which a tolerably extensive experience in hospital and private practice has led me to consider as the most safe and effectual.

The treatment of chancre is of a *local* and of a *constitutional* character. The local treatment has for its object either to destroy the poisonous character of the sore, or to modify it so as to bring it into the state of a healthy ulcer; the constitutional treatment is not only intended to facilitate this, but to prevent, if possible, infection of the general system with the poison of constitutional syphilis, should this have been communicated with the local disease.

Local treatment.—This has for its object either the destruction or the modification of the specific character of the sore. The complete destruction of the local virus should always, if possible, be effected; and if this can be done in the early stage of the disease, the healing of the sore will be much expedited. But, even though considerable time have passed before a surgeon sees the sore, it is well to destroy the ulcerating and poisonous surface, that its further extension may be prevented. This should be effected by the application of caustics in a sufficiently concentrated form to destroy radically and at once the specific character of the sore, so as not only to save the pain, but to prevent the irritation attendant upon frequent applications. The nitrate of silver, which is commonly used for this purpose, is too weak to secure the effect it is intended to accomplish, being apt to irritate and inflame, and not to destroy the chancrous surface, thus necessitating repeated and painful applications. I consequently prefer to this the strong nitric acid, one application of which will very commonly suffice to annihilate the specific character of the sore; though more energetic in action, it does not give rise to more pain than the nitrate of silver. It should be applied by means of a piece of wood, a glass rod, or a small dossil of lint wrapped round the end of a silver probe; with this the sore may be freely mopped, and then, a stream of cold water having been poured over it to wash away any superfluous acid, a slight poultice or a piece of water-dressing should be laid on; after the small slough produced by the caustic has separated, a healthy granulating surface will be left. The caustic may be applied at any time during the continuance of the specific condition of the sore; but when once this has been destroyed, it should not be reapplied. The potassa fusa and the potassa cum calce, though occasionally used, are far less manageable and not more efficacious applications than the nitric acid.

These are the means that are generally most useful in *simple chancres*. In some cases, however, inflammation of the sore, or peculiarities in its situation, demand modifications of the treatment.

If there be much inflammation about the sore and prepuce, this must first be subdued by the application of cold poultices, or of lead and spirit lotion. When this is removed, if the sore have not lost its specific character, the caustic should be applied in the usual way.

Should there be phimosis with discharge of chancrous pus from under the tightened prepuce, it will be better to slit this up, so as to expose and freely cauterize the subjacent chancres. If the cut edges of the prepuce become inoculated, they must also be cauterized freely and early.

If the chancres be situated round the orifice of an elongated and tight prepuce, circumcision is the best means of removing the disease and the inconvenience at the

same time. The cut surface, however, will always become infected, and require to be freely cauterized with nitric acid.

After the slough produced by the caustic has separated, the surface may begin to granulate healthily at once, requiring but simple dressings; but in the majority of cases it will continue in a somewhat unhealthy condition, demanding special topical applications to cause it to cicatrize soundly. If it be weak and fungating, an astringent lotion, such as the following, will be found most useful: ℞. Tannin, ℈j; Tinct. lavandulæ comp. ℥ij; Vini rubri, ℥iv. Ft. lotio. Or a solution of sulphate of copper may be applied, and the sore touched from time to time with the nitrate of silver. If there be induration at its base, the black or yellow wash will perhaps be found the best application that can be used.

When the chancre is indurated by syphilis, no attempt should be made to burn away the indurating base with caustics, as it will prove unsuccessful, the cause of the induration being always beyond the influence of the caustic. In these cases, the best local application is generally the black wash.

In the *phagedænic chancre* a different management is required. If there be much irritability about the sore, the nitric acid cannot be borne; and here the best application is an opiate lotion, conjoined perhaps with small quantities of the chloride of soda. If the part require more stimulation, a few drops of the dilute nitric acid may advantageously be added instead of the chloride. In these cases, however, the application of the strong nitric acid may often be required at a later period of the affection, on the removal of the local irritation by the topical employment of sedatives. In many cases, again, the local inflammatory action is best removed at first by the application of the concentrated nitric acid, this being followed by opiate lotions or emollient poultices, and the caustic being reapplied whenever there is a tendency to the extension of the disease.

In *sloughing chancre*, when the prepuce is greatly tumefied, in a state of inflammatory phimosis, and of a deep red or purplish color, with threatening of extensive gangrenous action, a director should be passed between it and the glans penis, and the swollen prepuce slit up. In this way tension is removed, and the extension of the sloughing action arrested. Any chancre that is exposed must then be freely touched with nitric acid. Should the parts already have fallen into a state of gangrene, emollient and antiseptic applications will generally be found to agree best: yeast, carrot, opiate, charcoal, or chlorinated poultices should be employed, the sloughs removed, and any parts, as portions of the prepuce, that are partially destroyed by the gangrenous action, slit up, so as to remove tension and lessen inflammation. In cases of inflammatory sloughing of the penis, the hemorrhage, that occasionally results from some of the bloodvessels of the organ being opened by this action, may, if moderate, be looked upon as highly beneficial, inasmuch as it is often followed by an arrest of the morbid process. If, however, it occurs to an alarming extent, the patient should be put under chloroform and the actual cautery freely applied. This not only stops the bleeding, but arrests the progress of the sloughing action. When once the chancre is healthily granulating, it must be dressed in the same way as any common ulcer.

In using lotions to any form of chancre, care should always be taken to keep a piece of lint soaked in the fluid constantly applied between the prepuce and the glans, and, in women, between the opposite labia; for, unless this be done, the contact of the diseased and inflamed mucous surfaces with one another will tend to keep up irritation and morbid action.

Constitutional treatment.—The *simple, soft, or excoriated chancre* will readily heal under the non-mercurial treatment; but, contrary to the opinion of many surgeons of the present day, I consider it much safer to put the patient upon a mild course of the iodide of mercury.

[The experience of American surgeons is decidedly in favor of treating the soft chancre or simple sore by local measures only, or if constitutional remedies be administered, such only as are indicated by the patient's general condition.—A.]

The constitutional treatment of *phagedænic chancre* must be directed by general medical principles; rest in bed, a mild diet, the administration of salines and opiates, in those cases in which there is inflammation and irritation conjoined; whilst in those in which there is a debilitated or cachectic condition, tonics, such as bark or iron, with good food and stimulants, may be required, together with opiates to allay pain and to procure rest. The preparations of iron, especially the ammonio-citrate

and potassio-tartrate, either alone or in combination with sarsaparilla, are especially useful in these cases. In the phagedænic chancre mercury is seldom admissible, and does much harm if employed to check any syphilitic taint that may be present with the sore. Indeed, it is the indiscriminate use of mercury in these cases that has, I believe, brought so much discredit upon this remedy in venereal diseases. But, although mercury is not generally admissible in phagedænic chancre, yet, in that form that is characterized by a white slough, it has been found useful by Wallace, and the utility of this practice I can confirm, having found it of service in some of the more rebellious varieties of this disease; the mineral must, however, be very cautiously administered, and in but small doses.

In the *gangrenous* or *sloughing chancre*, the constitutional powers of the patient will be found to be broken, and his general health depressed, so that depletory measures are seldom if ever required. The prepuce should be slit up, and free incisions should be made through the sloughing textures, so as to take down all tension; and as the fever subsides, or from the first if there be much asthenia, ammonia and bark, good nourishment, and abundant stimulants, will be required; eventually the patient's strength may be supported by iron and quinine, and the irritability of the system allayed by the free administration of opium; the strong nitric acid should then be mopped freely over the parts, and afterwards charcoal or yeast poultices applied until the sloughs have separated. After the separation of the sloughs, the sore will usually present a clean appearance, the granulations cicatrizing rapidly. It often happens that, when a portion only of the prepuce has been destroyed, the upper part being perforated, and the preputial orifice with the under part hanging down under the glans, the part thus projecting may be snipped off with advantage, and the organ thus moulded into a better shape.

After a chancre has been healed in one or other of these ways, we must endeavor, by the general improvement of the patient's health, to prevent or alleviate the manifestation of syphilis, should that malady have been contracted at the time of contagion. This is usually best done by putting him on a course of sarsaparilla with the mineral acids, and by scrupulous attention for some months to his habits of life. The syphilitic poison may linger for a great length of time in the system, not declaring itself by any overt manifestations so long as the health continues good; but, if the patient fall into a debilitated state, even though some years have elapsed, showing itself by some of its local effects.

CONSECUTIVE SYMPTOMS OF THE LOCAL CONTAGIOUS ULCER.

Chancres are not unfrequently followed by a series of affections which may be termed *consecutive*, depending as they do upon the primary disease, but being local in their character, and presenting no evidence of constitutional infection. These consecutive symptoms are three in number: viz., Contraction of the chancrous cicatrix, Bubo, and Warts.

Contracted Cicatrices.—Most excoriated chancres are healed without any cicatrix or other trace of them being left; but, in the phagedænic and the sloughing chancres, there is always loss of substance, often to a considerable extent, and consequently a depressed scar. But in addition to these thickenings, one of another kind may take place. The situations of all venereal ulcers should be watched for some time, however readily the sore may have healed; lest, the syphilitic virus having been introduced with the local irritant, induration should commence at the point of contagion, when the time of incubation or inactivity of the virus after its introduction has elapsed. Thus, a month or six weeks should pass away after the suspicious connection, before the surgeon pronounces the patient free of general syphilis.

Bubo.—By bubo is meant an inflammatory enlargement of the lymphatic glands which receive the lymphatic vessels supplied to the inoculated surface. A bubo, though generally produced in the groin by absorption of irritating matter from chancres on the penis, may occur elsewhere; as, for instance, in the axilla, in cases of chancre on the finger; in the submaxillary region, if the disease occur on the lip. The enlargements of the inguinal or other lymphatic glands that occur in cases of venereal chancre, are caused by several kinds of irritation. The glands may be irritated by concomitant inflammatory action about the penis, as when balanitis or phimosis are present; or they may be enlarged from the simple excite-

ment of the parts, especially in strumous and debilitated subjects. In these cases the bubo is termed *sympathetic*, and the affection must be considered as a simple irritation and inflammation of the inguinal glands, which may speedily subside under proper antiphlogistic treatment of a mild kind, although in many cases suppuration eventually takes place, constituting, in fact, a simple glandular abscess, presenting nothing in any way specific. Indeed, it scarcely ever happens that a chancre has existed for some days without the lymphatic glands in the groin becoming enlarged and somewhat indurated, especially those that lie parallel to Poupart's ligament, their enlargement being attended with a degree of stiffness and dragging pain. The liability to this irritation and inflammation of the glands in the groin is greatly increased by the patient walking about or otherwise exerting himself. But I do not think that causes such as these influence the occurrence of the other and more serious affection of the lymphatic glands; namely, the *virulent bubo*, which appears to originate from direct absorption of the chancrous pus, without the interference of any external agency. When once the glands in the groin have become virulently irritated, it is extremely difficult, if not impossible, to prevent suppuration from taking place. Most usually only one or two glands suppurate, although several may be enlarged; and very commonly the disease is confined to one groin only, though both may be affected, more particularly if the chancre be situated upon the frænum. The suppuration may be limited to the gland immediately affected, or it may extend into the surrounding areolar tissue, or even be chiefly confined to this.

The true specific virulent bubo is essentially produced by the absorption and deposit of the venereal virus in the substance of the gland, the tissue of which becomes poisoned; so that we may consider with Ricord that a virulent bubo is, properly speaking, a chancre of an absorbent gland, differing only in seat from that which is situated upon the surface of the body. Ricord has observed, and I have often had an opportunity of testing the correctness of this observation, that the pus of a virulent bubo is as readily inoculable as that of an ordinary chancre. This kind of bubo, then, may be considered as a *specific* abscess of the absorbent glands and surrounding areolar tissue. It runs the ordinary course of an acute abscess, often undermines the skin to a considerable extent, with much red or purple discoloration, and, when it has burst or been opened, presents a ragged sloughy-looking cavity, having an unhealthy appearance; it most usually occurs about the second or third week after the first appearance of the chancre, but may happen at an earlier or at a later period, even after the chancre itself has healed.

Primary Bubo.—The French surgeons have described a form of bubo that they call *bubon d'emblée*, or *primary bubo;* this is said to occur from the direct absorption of the chancrous matter, without the previous formation of a chancre. Scarcely any satisfactory proof, however, has been given of the existence of such a bubo. It frequently happens that small excoriated chancres heal in a few days, before which time, however, the inguinal glands have become irritated and enlarged; and, as the enlargement of the glands goes on after the healing of the chancre, a bubo may be formed when all trace of its primary source has entirely disappeared.

This primary bubo has fallen under my observation in one case only. Until that occurred, I doubted its existence; and I am not yet fully convinced that this suggested mode of origin is the true one. In the case referred to, a young man applied to me with a rather large abscess in the groin, for which I sent him into the hospital. On being questioned, he denied ever having had any venereal disease, though he admitted having had intercourse with a woman of the town. On examining the penis, no chancre, abrasion, or cicatrix could be discerned. The abscess was opened, and two ounces of rather bloody and very thick pus were let out; no enlarged glands could be seen. For the sake of experiment, the pus was inoculated into the left thigh, and two distinct and well-marked pustules were produced. That such an effect can be obtained by matter of very irritable character without any venereal origin, is shown by the experiments of several surgeons who have succeeded in inoculating matter from itch and ecthymatous pustules; hence it must not be concluded in this case that the bubo was consequent on the direct absorption of venereal matter along the lymphatics.

[It is impossible to be sure in such cases that because no cicatrix is observed, therefore no chancre has existed. The balance of evidence, both in this country and in Europe, is decidedly against the possibility of the *bubon d'emblée*.—A.]

Creeping Bubo.—In some cases the bubo, as has been well shown by Solly, as-

sumes a tendency to creep or spread over the neighboring integument, extending in this way to a considerable distance down the thigh, upon the abdomen, or over the ilium. This *creeping bubo* is characterized by the peculiar semicircular or horse-shoe shape that the sore assumes, and by its tendency to cicatrize by one margin, whilst it slowly extends by the other; the cicatrix always being thin, blue, and weak, closely resembling that of a burn.

After a bubo has disappeared, a good deal of induration may be left in the glands of the groin, together perhaps with matting of the surrounding areolar tissue; and this induration may continue for years, or even for the remainder of life.

The *treatment* of bubo consists, in the first instance, in endeavoring to prevent the occurrence of suppuration; and, should this take place, in letting out the matter and closing the wound which results.

The *preventive treatment* of bubo is of considerable moment; for if suppuration take place, a tedious result will often be entailed on the patient. It consists essentially in perfect rest of the part, and the application of leeches, and of cold lead poultices. In reference to the application of leeches, there is a practical point of considerable importance that requires attention—viz., that the leech-bites may become infected by the chancrous pus, and thus converted into a number of new chancres. This accident is best guarded against by covering the bites with collodion and plaster.

If there be not much inflammatory action about the bubo, but this be indolent and chronic, the application of blisters, of discutient plasters, or of the tincture of iodine, is occasionally useful. A plan of discutient treatment recommended by a French army-surgeon, Malplaquet, I have found very serviceable in several cases. It consists in applying a blister about as large as a half-crown over the surface of the inflamed gland, and dressing the raw surface produced by it with a piece of lint soaked in a saturated solution of the bichloride of mercury for a couple of hours, when a white eschar will have formed; a cold poultice should then be applied, and continued until all excited action has gone down.

If, notwithstanding our endeavors to prevent suppuration, matter form within or around the gland, as evinced by the swelling becoming soft, boggy, and inflamed, it should be *freely opened* by either a horizontal or a vertical incision, whichever will give the readiest outlet to the pus. If the integuments be much thinned, undermined, and of a bluish color, I prefer making the opening with potassa fusa, as it destroys those unhealthy tissues which would otherwise interfere with the cicatrization of the wound. The cavity that is now exposed presents a chancrous appearance, being irregular and sloughy, with elevated and angry red edges. This should be dressed with the aromatic wine and tannin lotion (p. 519). If we find that the character of the sore does not improve, the potassa fusa should be freely applied to its surface and edges, and after the sloughs have separated, the granulations may be dusted with red precipitate powder; the cicatrization will in many cases be much facilitated by the application of a compress with a spica bandage, and by keeping the patient at rest. Not unfrequently the healing of the sore is interfered with by the overhanging of the undermined edges; these may occasionally be made to retract by being freely rubbed with the nitrate of silver. If this do not succeed, it may be necessary to pare them off with a knife or scissors, or to destroy them with potassa fusa; the sore should then be dressed from the bottom, and treated on general principles. Sometimes sloughing action is set up in the open bubo, and then extensive destruction of tissue may ensue, and even fatal hemorrhage from the femoral artery has been known to occur. If there be signs of syphilis concomitant with this local bubo, such as several indurated glands, or rash upon the skin, it is as necessary to employ the continuous administration of mercury to cure the latter disease, as if the local affection were not present.

Venereal Warts.—Various forms of warts occur independently of any constitutional affection, from simple continued irritation of the muco-cutaneous surfaces. They commonly occur on the prepuce or glans, and are especially apt to be situated in the angle between these parts; they are of a bright-red color, very vascular, and, if left without interference, may increase immensely in size and number, distending the prepuce, and giving a clubbed appearance to the penis; there is always phimosis attending them, and the tension of the prepuce may be such, that ulceration occasionally takes place in it, giving rise to a protrusion of these growths through

an aperture in its side. These warts are occasionally met with in the vagina, forming large, irregular, cauliflower-looking masses. The *treatment* consists in snipping and paring them off with scissors, and afterwards touching the parts from which they spring with nitrate of silver, to prevent their recurrence. In order to do this effectually, it is necessary to lay open the prepuce in all those cases in which the glans cannot be freely exposed by drawing this back.

II.—SYPHILIS, OR CONSTITUTIONAL VENEREAL DISEASE.

Syphilis is a specific disease, transmissible (1) by the contact of its own specific pus with a tender, or, at least, an abraded surface; (2) by inoculation into the system through the medium of the secretions; or (3) by hereditary taint under certain special conditions. It manifests itself not so much by the occurrence of any one special affection, as by the tendency it occasions to the development of inflammation in various tissues and organs, and by the peculiar impress that it communicates to the form and course of the inflammatory affections it induces.

The early and more common consequences of this affection have long been called *primary* and *secondary* syphilis. These terms are ill suited to our present knowledge of syphilis, for it is now established that the induration at the point of contagion and the enlargement of the neighboring lymphatic glands are as much a part of the disease as are the eruptions of the skin and mucous membranes; which, in the great majority of cases, shortly follow the appearance of the former. But, as they have the sanction of custom, they may be employed to indicate the different phenomena of the disease. Thus, *primary syphilis* is used to denote the induration and ulceration that take place at the point of contagion, and the indolent enlargement of the nearest group of the lymphatic glands. *Secondary syphilis* denotes the various eruptions of the skin and mucous membranes, and the inflammation of the eye, and the periosteum, which take place in the first two years after contagion, but may return by relapses of the disease after much longer periods. Lastly, the term *tertiary syphilis* includes peculiar consequences of syphilis that appear in a small proportion only of those infected, and which affect the body, especially the viscera, with processes of a slow inflammatory character, that are seldom set in action until the ordinary course of the disease has terminated.

Syphilis may, then, be regarded as presenting two orders of symptoms, the local and the constitutional. The *local* or *primary* symptoms occur only on the part to which the virus is immediately applied, and are the consequences of the introduction of the poison at the point of inoculation. The *constitutional* or *secondary* symptoms are the results of the absorption of the poison into the economy, whereby most of the tissues and many of the organs of the body are affected; they are capable of hereditary propagation, and, in certain circumstances, of transmission through the secretions.

It would be altogether foreign to the scope of this work were I to enter into the very curious and interesting question as to the *origin of syphilis*, a subject that admits of much dispute, and which has been keenly argued. After an attentive examination of it, I think there can be little doubt that syphilis was either introduced into Europe, or originated there *de novo*, towards the end of the fifteenth century. There is no mention made by the medical writers, historians, or poets of antiquity of any contagious disease arising from sexual intercourse affecting the genital organs, and followed by constitutional symptoms. The disease, when it first attracted public attention at the close of the fifteenth century, was looked upon as a new and previously unknown affection. It was supposed to be infectious as well as contagious, and its treatment was not understood. This would scarcely have been the case had it been previously known by personal observation, or even by tradition, to those then living. If it had previously existed in the old world in a mild or modified form, different from what we now observe, it is certain that about this time it suddenly assumed great intensity, all its symptoms being aggravated in a remarkable and fearful manner, presenting characters which had not been previously alluded to, but which have often been reproduced in modern times; as, for instance, in those severe forms that were observed in the British armies during the Peninsular war, and, according to Larrey, among the French troops during Napoleon's German campaigns.

Transmissibility of Syphilis.—That syphilis can be communicated through

the contact of its specific pus with an abraded or tender surface, is fully established; but the question as to the contagiousness of secondary syphilitic discharges, or of the secretions of individuals laboring under constitutional syphilis, is one that is still in an unsettled state; and, before it can be settled, very extended and accurate observation is required for the elimination of those sources of error, which are inseparable from an inquiry in which the morality of patients often constitutes an important element in the investigations. The following appear to me to be the chief points that may be looked upon as decided with tolerable certainty, though many of them are still subjects of controversy.

Constitutional syphilis is contagious; that is to say, it is communicable from one individual to another through the medium of the discharge of one of the sores that may form during its continuance. The fluids which by direct experiment are proved to contain the virus in a communicable form are the secretions of all the early syphilitic eruptions; of these, the most common are the thin discharge of mucous tubercles, or of the initial ulcer. The blood itself, in more than one instance, has been inoculated with success. Professor Pellizari, of Florence, inoculated a young surgeon, Dr. Bargioni, on the 6th of February, 1860, with blood taken from the vein of a woman suffering from syphilitic eruptions. The site of the inoculation, which was carefully protected by a watch-glass cover, remained quiet for twenty-five days; then a papula developed, which in forty-four days became an ulcer with hard base. On the sixty-fifth day after inoculation, a roseola broke out on the trunk. Some uncertainty still exists as to whether the natural secretions of syphilitic persons are contagious of themselves, or become so by admixture with the blood or the discharge of syphilitic affections. The saliva, the milk, and the semen have been variously accused of this power. Syphilis is hereditarily transmissible from parent to offspring; it is said to be communicable to the female by impregnation by a diseased male, and even through the medium of the semen without impregnation. It is also believed by some to be communicable to the mother from a diseased fœtus in utero, the parent being thus poisoned through her own offspring. There are certain rare cases in which it has been communicated from nurses to children, and *vice versa*, in the act of suckling, through the medium of sores or mucous tubercles on the nipple or mouth, and possibly through the secretions. And there occasionally occur cases in which the male is infected by the diseased secretions of a syphilitic female during sexual intercourse, without there being any local sore through which the poison can be proved to be conveyed into the system.

[Cullerier has shown that there is no proof of contagion through the medium of the secretions; the only possible exception is in the case of the semen. Hence in the cases referred to in the text it is allowable to believe that a local sore did exist, though it escaped detection.—A.]

Ought a man affected by constitutional syphilis to marry? is a question that is frequently put to the surgeon, and one to which it is by no means easy to give a direct and immediate answer. That a man laboring under constitutional syphilis is liable to infect a healthy woman, either directly or through the medium of her fœtus, or to become the progenitor of syphilized children, there can be no doubt; but that he will necessarily do so, is certainly not the case. In answering the difficult question that is thus frequently raised, the surgeon must be very cautious; he must bear in mind that the health and happiness of a woman and the future of a family are often dependent on his reply; and that, should he give his consent to the union and evil consequences follow, the whole responsibility will be thrown upon him. I think that it may be stated generally, that no man ought to marry for at least twelve months after the first development of constitutional syphilis, even though all local signs of the disease have disappeared, and that he ought not to do so whilst any local manifestations of the disease are developing themselves, whatever time has elapsed since the commencement of the attack. But, although I believe that it is safer to follow these general rules, yet I have seen so many cases in which marriage has been contracted by men still suffering from occasional manifestations of the slighter forms of constitutional syphilis, and yet no evil consequences have been entailed either in wife or children, that, although it may be safer, yet it cannot be absolutely necessary to adhere closely to the advice just given. I know instances in which men who had contracted syphilis before marriage, and had been imperfectly cured—having for many years (ten, fifteen, or even twenty) occasional outbreaks of cutaneous syphilides, sarcocele, gummata, and

other varieties of the advanced forms of the disease—have been the parents of perfectly healthy children, and have never infected their wives.

It is tolerably well established that syphilis is occasionally communicated with other affections. The matter of local chancre may thus be contaminated with the syphilitic virus, if the two affections be present in the same person. Syphilis has also been spread widely among young children by vaccinating them with lymph from a syphilitic child. One of the most unquestionable of these accidents is that which occurred in the Subapennine valley of Rivalta in Piedmont, in 1861. Dr. Pacchiotti, of Turin, who was employed by the Italian government to report on the attack, has published an account of it. The facts are shortly these. In May, 1861, an apparently healthy child, named Chiabrera, was vaccinated at Rivalta with lymph sent from Acqui for the purpose. Ten days after this vaccination—on June 7th—forty-six healthy children were vaccinated at one sitting from this child. Again, on the 12th June, seventeen other healthy children were vaccinated from one of the forty-six. Thirty-nine of the first series of forty-six, and seven of the second series of seventeen, received syphilis with the vaccine disease, making a total of forty-six out of sixty-three children in a mountain village simultaneously inoculated with syphilis. Some months elapsed before the vaccination was suspected to have been the source of the children's bad health. By the 7th October, when attention was drawn to this spreading disease, six of the forty-six syphilized children had died without receiving any treatment, fourteen were recovering, and three were in a precarious condition. Twenty-three were dispersed through the country, and their condition was unknown until further researches traced them out. In addition to the children, twenty women suckling them were inoculated with syphilis from the children; through the mothers, the disease had reached some of the husbands and even the elder children of the different families.

Progress.—The consequences of contagion are not immediately manifested. The time that intervenes between inoculation and activity of the poison is called the *incubation period.* It may be occupied in three ways. If the vehicle containing the virus be of a non-irritating character, the broken surface heals, and all trace of the inoculation disappears until the incubation is completed; or, as the vehicle of the virus is often pus or discharge of an irritable kind, it may cause immediate inflammatory action at the point of inoculation. This irritation subsides in a short time, and the part then remains quiet until the incubation is complete, when the syphilitic poison betrays its presence by characteristic phenomena. An experiment of Vidal's illustrates this: he inoculated the matter of a pustular syphilitic eruption on the arm of a medical student, which produced a pustule in a couple of days; this healed over in about a fortnight, and the experiment was supposed to have failed until the thirty-fifth day; action then recommenced by the development of a papule, which subsequently ulcerated, and general syphilis followed in due course. If the syphilitic virus be carried in the pus of a local contagious chancre, the time of incubation is often occupied by the course of a chancre, which may or may not have healed over when the syphilitic poison begins its action. This series of events, first a suppurating contagious sore, and then induration forming in the base of the sore, or in its scar if the sore has already healed, is perhaps almost as common as the inoculation of syphilis unaccompanied by immediate local irritation; but the two morbid actions have no connection with each other, and are only accidentally coexistent.

The length of this time of inactivity varies in different persons; its common length is twenty-five days. The shortest known period before the poison began to reveal its presence has been ten days, and the longest forty-six days. When the time of active progress has arrived, the point of contagion becomes an elevated hard copper-colored spot, which sometimes ulcerates, and if irritated does so freely, forming the indurated or Hunterian chancre. Not unfrequently the surface scarcely ulcerates, but is simply eroded; and even erosion may be wanting, in which case the only change on the surface is simple desquamation of the cuticle.

The Indurated or True Hunterian Chancre, as it is termed, is not by any means so frequently met with as the other manifestations of syphilitic inoculation. The great characteristic of this form of venereal ulcer is the induration of its edges and base; and this character is met with from the very first. Any ulcer, but more especially the chancrous excoriation, may during its progress become indurated from undue stimulation, or from being otherwise improperly inflamed; but the Hunterian

chancre is indurated from the very first, and continues so throughout. This induration of the base is the result of a peculiar plastic effusion, which, though it microscopically and chemically resemble ordinary healthy lymph, yet very distinctly differs from it in its vital characters. Besides the presence of this induration, the Hunterian chancre is characterized by its circular shape, its elevation above the surrounding parts, and the very adherent gray slough that covers its surface. It is usually seated on the glans; but not unfrequently on the skin of the prepuce, or of the root of the penis. In this form of chancre there is almost invariably enlargement of the lymphatic glands in the groin.

Seat and Number.—The indurated primary ulcers of syphilis are most frequent on the *genitals*, but not so exclusively limited to those parts as are local venereal sores, because syphilis is communicated in various ways besides that of sexual intercourse, and thus may appear on any part of the body. Fournier found that, of 472 cases of inoculation in men, 314 were on the prepuce and glans penis, 109 on other parts of the male organ, 12 only on the mouth, 6 on the hands and fingers, and a few on the eyelids, tonsil, and navel.

Syphilis not unfrequently occurs amongst surgeons and accoucheurs as a consequence of inoculation on the *fingers*, during the dressing of a venereal sore, or the delivery of a diseased woman; and is also occasionally met with among non-professional people. It usually appears as a small sore by the side of the nail, and under its matrix, with much swelling, redness, and pain in the finger, which becomes bulbous; pain and swelling of the axillary glands soon follow. If the nature of the disease be not recognized, the ulceration will creep round the tip of the finger, have a foul and sloughy look, with exquisite tenderness, and, resisting all ordinary treatment, may be set down as malignant; on which supposition the amputation of the finger may be proposed and practised. I have seen at least four cases in which this extreme measure has been proposed, but in which a timely discovery of the true nature of the affection caused the finger to be saved.

In some cases of disgusting depravity, chancres are met with at the *margin of the anus* and on the *lips* and *tongue*. These are always indurated; and from their foul surface, hard base, and persistent character, may readily be mistaken for cancerous affections. Inoculation will always test this point.

[Labial or lingual chancres may be readily acquired by contact with secondary lesions of the buccal mucous membrane, as in the act of kissing an infected person. Though the fact is apparently not recognized by the author, it has been, I think, clearly established by the researches of modern syphilographers that *the initial lesion of syphilis is always a chancre.* Hence it is an error to suppose that the existence of a cephalic chancre is any proof of its possessor having indulged in *rapports contre nature.*—A.]

Induration.—The hardening of the tissue around the point of inoculation, varies in the extent to which it is developed. It is best developed in the skin, where it takes the form of a nodule or lump, often no larger than a split pea, but sometimes as large as a walnut. Now and then on the thin prepuce it is spread widely in a shallow layer, and gives the foreskin the "parchment induration" of Ricord. This induration remains for some time around the point of contagion, usually two or three months, though, when very scantily developed, it may vanish in a fortnight or three weeks. Ultimately it always disappears; though, if irritated, it is very apt to break down into obstinate ulcers.

It is maintained by many surgeons of great authority, that induration of the site of contagion is by no means a constant production. The number of cases where induration is not palpably evident is very small; and, though probably it is sometimes wholly wanting, it is a rare exception for it to be so.

Much induration is often thought to produce a severe course of syphilis, and probably this is generally true; though, and especially when treatment is early employed, the patient often escapes all subsequent symptoms, except a few spots on the skin and sore throat.

Indolent Enlargement of the Lymphatic Glands.—The so-called *indolent bubo* is the next change to follow induration of the point of contagion, which it accompanies or very closely succeeds. One gland enlarges first, and several follow; they remain painless or only very slightly tender; the skin over them retains its natural color and suppleness, and there is no doughy thickness, as in the acute suppurating bubo. In this state the glands, nevertheless, not unfrequently suppurate, and an abscess

forms around them. This accident is generally set up by violent exertion, such as dancing, riding, and the like; but it has no special significance—it never yields a specific inoculable pus like the virulent bubo of the local chancre. The anatomical change in the glands themselves consists in congestion and the deposit of irregular fibro-plastic lymph, which produces their increased size. If the point of contagion be seated near the middle line, at the frænum, for instance, the glands in both groins are often enlarged.

In weakly persons, the glands throughout the body become enlarged; those at the back of the neck, especially, are very commonly enlarged during the time of the eruption on the skin, and those of the axilla and other parts are sometimes included in the enlargement. This condition of the glands is accompanied by a great increase in the proportion of colorless corpuscles in the blood; but both these alterations of the lymphatic system are temporary, and disappear spontaneously in a short time.

Treatment.—*Local treatment*, while of much value in the non-syphilitic venereal sore, is of little or no avail in the disease now under consideration; the causes of the local manifestations being beyond the reach of any direct application. The treatment must be directed to the neutralization of the action of the poison, and its removal from the constitution, by remedies given so as to act generally on the system.

The *constitutional treatment* of primary syphilis has undergone various changes according to the prevailing doctrine of the day. It had been decided by the surgeons of the last and early part of this century, that mercury acted as a specific against the syphilitic poison. This doctrine was so firmly established, that Hunter, and many of the great surgeons of his school, looked on the curability of a sore without mercury as a proof that it was not syphilitic.

About the commencement of this century, however, it was found by observations of the army-surgeons, amongst whom Rose took a principal share in the inquiry, that the different forms of venereal ulcer, no distinction being then drawn between the local non-infecting sores and the ulcers which resulted from the contagion of the constitutional disease, were curable without the necessity of administering mercury, or indeed of having recourse to any specific treatment whatever.

These observations, which appear to be founded on what was witnessed in Spain and Portugal during the Peninsular War, led to the introduction of an important modification in the treatment of venereal sores; viz., the *non-mercurial* or *simple* plan, as it is termed; a mode of practice that obtained great favor, and has been extensively tried. Of late years, however, a reaction has taken place in the minds of most professional men, and mercury is again employed in the treatment of this disease, but more moderately and scientifically, and consequently more successfully than before.

The arguments in the favor of the non-mercurial plan of treatment are briefly these: that by this system of treatment the constitution of the patient is saved the introduction of a mineral which in many cases acts injuriously, and which, as the disease can be cured without it, may at all events be looked upon as unnecessary; that secondary affections less frequently follow this plan than they do the administration of mercury; and, lastly, that those distressing cases of constitutional syphilis which are common after mercurial courses, and which are said to depend upon a peculiar combination of the syphilitic poison and the mineral in the system, are never met with in persons who have undergone the simple treatment. These arguments, however, on closer examination and further experience, have been proved to be not quite so conclusive as the supporters of the simple treatment appear to believe. That a great number, perhaps the majority, of cases of simple soft chancre, which we now know to be an affection of a totally distinct nature from syphilis, can be healed without the administration of mercury, is undoubtedly the fact; but it is equally true in many instances that the indurated sore does not cicatrize properly unless the mineral be administered, or, if it do close, that it heals in an imperfect manner, readily breaking out again. But it is a most serious error to confound the healing of ulcers with the cure of syphilis. The cicatrization of an ulcer and neutralization of the constitutional infection are two distinct things; and the test of the relative value of these two plans of treatment must depend rather on the influence they have over the course of syphilis, and on the character that the symptoms assume under one or other of these methods, than on the mere skinning over

of the ulcer. I cannot agree with the statement that secondary symptoms are less frequent after the simple than after the mercurial treatment of syphilis. I have seen the non-mercurial plan of treatment very extensively employed at University College Hospital; indeed, it was formerly almost invariably practised there, more particularly in the syphilitic cases occurring among the out-patients under the late Mr. Morton, who strongly advocated it; and I have had repeated occasion to observe the frequency with which it was followed by secondary symptoms. In private practice, also, I have had considerable opportunities of comparing the two methods; and I can safely say that I have seen the simple treatment more frequently followed by secondary symptoms than the mercurial plan has been, when properly and judiciously employed. The supporters of the non-mercurial treatment, when obliged to admit the great frequency with which it is followed by secondary symptoms, argue that these, if more frequent, are less severe after the simple than after the mercurial plan; and they state somewhat dogmatically, and it appears to me without any evidence to support their statement, that mercury and syphilis together form a sort of poisonous compound in the system, which produces the worst and most destructive forms of constitutional syphilis. I deny entirely, however, that we have any proof of the existence of such a combination as that which is supposed to be produced by syphilis and mercury; no evidence with which I am acquainted has ever been adduced in support of the formation of such a poison in the system. It is doubtless true that, after an ill-regulated mercurial course, constitutional syphilis of a very severe character may occasionally appear; but this seems to me to be rather owing to mercury having been improperly administered in constitutions that will not bear it, and in which, by the induction of a cachectic and depraved condition of the system, it favors the occurrence of some of the more severe forms of secondary syphilis, in the same way that any other lowering plan of treatment, or simple debility, might occasion them, but without the exercise of any specifically injurious influence. Some of the worst forms of constitutional syphilis that I have of late seen, occurred in patients to whom no mercury had been administered, but in whom the syphilitic virus had been allowed to exercise its influence unchecked, save by the so-called simple treatment. I have seen the body covered by immense ecthymatous crusts and sores in one case, rupial ulcers with destruction of the nose and palate in another, the worst kind of syphilitic cachexy with the tuberculo-pustular syphilide in a third, and extensive disease of the cranial bones and the clavicle in a fourth; in none of which had any mercury been administered.

But, though I cannot admit that the supporters of the simple or non-mercurial treatment of syphilis have brought forward any proof of its superiority over the mercurial plan, and though my own experience has taught me that secondary symptoms occur after it with no less severity, and with far greater frequency than they do when mercury is carefully and judiciously administered, yet I am quite ready to allow that there are certain conditions of syphilis in which the non-mercurial treatment is alone admissible, the state of the constitution or the disease being such that mercury cannot be given in any form. In these cases such a treatment must be adopted, in accordance with ordinary medical principles, as will tend to subdue local action and improve the general condition. It is, indeed, especially in individuals of an unhealthy or strumous habit of body, or in those who are suffering from local visceral disease of some kind, and who are not affected by an indurated chancre, that this plan of treatment should be adopted. So also in those who, from the nature of their occupations, are subjected to much exposure to wet and cold, a mercurial course cannot be properly or safely administered, and the simple treatment is the most advisable plan that can be adopted. But even in such individuals mercury is often necessary to destroy the activity of the disease. In all other cases, I am certainly of opinion that mercury ought to be administered; and this opinion appears to be entertained by the most experienced surgeons of the day in this country and in France.

The first question in connection with the employment of mercury in syphilis, has reference to the principle on which this remedy is administered. Whether mercury exercises a specific action over the poison of syphilis or not, has been much discussed, and is difficult of proof. I am certainly of opinion that it does act as a specific in syphilis, but that this specific action is much influenced by the condition of the system, the habits of the patient, and the mode of administering the remedy; these conditions under certain circumstances tending to counteract or otherwise to

interfere with its operation. That mercury in many cases is antagonistic to the syphilitic poison, appears evident from the fact that in some instances hard ulcers will not heal unless it be given internally; from its influence in speedily curing infantile syphilis and preventing after manifestations in the system; and from the fact that, when properly administered in *healthy constitutions*, it may almost to a certainty be expected to dissipate the various symptoms of constitutional syphilis. When it fails, as it doubtless does in many cases, to prevent the constitutional infection, or to eradicate this if it have appeared, the failure may usually be traced either to want of care in the administration of the medicine, or to the existence of an impaired state of the patient's health; though doubtless, in some cases, the most judicious employment of mercury is unsuccessful in arresting the progress of syphilis.

In connection with the administration of mercury in syphilis, therefore, various questions present themselves, the proper determination of which is of the first importance. These have reference to the state of the patient's constitution, the condition of the sore, and the mode of administration of the remedy.

The *state of the patient's constitution* influences materially the propriety of the administration of mercury. In ordinary healthy constitutions, it may always be safely employed; but, if the powers of the system have been broken by excesses of any kind, if the patient be of a strumous habit of body, if he be irritable, feverish, or excited, it must be given with great caution, or should be withheld until these states of the system are modified or removed. It is especially by administering mercury to strumous and cachectic patients, or to those whose powers have been broken by habitual dissipation, that so much mischief results; and that it occasionally gives rise, by acting as a depressing agent, to local sloughing, or to some of the low forms of secondary syphilis.

Mode of administering mercury.—The particular *preparation of mercury* to be given, the *length of time* during which it should be continued, and the *rules to be observed* during the mercurial course, are all matters that influence greatly the result of the treatment.

Mercury may be administered in three ways: by the mouth, by inunction, or by fumigation. When it is to be given by the mouth in early syphilis, and when it is desirable to produce but a moderate effect upon the system, I prefer the iodide of mercury, in doses of one grain three times a day; or the Plummer's pill, in five-grain doses twice or three times a day, will be found extremely useful when the constitution is somewhat irritable. If it be desirable to produce a rapid effect upon the system, five grains of blue pill may be given night and morning. The other preparations of mercury are not, I think, required in the primary form of the disease. When it is required to produce a moderate effect, especially in somewhat delicate persons, without irritating the system or inducing much salivation, the iodide is certainly to be preferred to all other preparations.

In some cases the bowels are so irritable that the administration of mercury by the mouth invariably purges the patient; in these circumstances, the mercurial inunction may be conveniently practised. This is best done by rubbing a drachm of the strong ointment into the inside of each thigh for ten minutes every night and morning; or by putting a similar quantity upon a piece of lint, and letting the patient wear it during the day and night in each axilla.

The duration of the mercurial course must depend upon the effect produced upon the sore; the course need not be continued until this has cicatrized, but should be persevered in until all specific action has ceased, and the sore has acquired a healthy and healing state. This impression is seldom produced upon the sore, without a slight effect upon the mouth having been previously induced; the gums becoming spongy, red, and swollen, and an increased flow of saliva taking place. It is never necessary to continue the mercury so long, or to give it to so great an extent, as to produce very profuse salivation. It was in attempting to do this, and by administering the remedy in too large a quantity, and too rapidly, that the older surgeons produced such injurious consequences. The effect upon the sore, rather than that upon the gums, should be our guide as to the proper time for discontinuing the mercurial.

The rules to be observed during a course of mercury exercise considerable influence upon the effects produced by it. The system should always be prepared for its administration by a free purge. While it is being given, the patient should, if possible,

be kept in bed, or at all events be confined to the house, taking as much rest as possible; the diet should be moderate and unstimulating, and the dress be as warm as the season will admit. If the mercury be given by the mouth, and gripe, it will be found useful to combine it with capsicum. If it purge, small doses of opium may advantageously be administered in conjunction with it. After it has been carried to the full extent deemed advisable, it should not be suddenly left off, but gradually discontinued by diminishing the quantity daily during a week or ten days. If it be given in accordance with these rules, and in proper constitutions, we shall seldom find any of those injurious effects produced that were formerly described as resulting from the administration of this mineral; those severe and extensive forms of ulceration of the mouth, leading to necrosis of the jaws, and the mercurial erythema or erethismus described by the older surgeons, are now happily almost matters of history, being but seldom if ever met with.

[Most modern syphilographers, whether unitists or dualists, acknowledge that the natural evolution of syphilis cannot be prevented by the use of mercury; and hence the administration of this drug for primary symptoms is now comparatively seldom resorted to. (See, upon this point, *Cullerier's Atlas of Venereal Diseases, edited by Bumstead*, and review in *Am. Journ. Med. Sciences*, Jan. 1869, pp. 123-4.)—A.]

SECONDARY OR CONSTITUTIONAL MANIFESTATIONS OF SYPHILIS.

The introduction of the syphilitic poison into the general system gives rise to two very important groups of phenomena: first, those that affect the system generally, influencing deeply the condition of the blood and the nutrition of all the textures of the body, occasioning febrile disturbance, followed by emaciation, cachexy, and general evidences of mal-nutrition; secondly, a variety of local diseases, which are characterized by distinct phenomena: 1. Modification of the epidermis and epithelium, as observed in mucous tubercles, psoriasis, and analogous affections, and ulcerations, affecting the skin and mucous membranes in various parts of the body; 2. The deposit of lowly organized lymph in various tissues and organs, as the periosteum, the iris, testes, &c.

The period at which syphilitic eruptions appear usually varies from six weeks to six months after the formation of the indurated sore. Occasionally secondary syphilis shows itself earlier, about the second or third week, when it may be coincident with the existence of primary syphilis. Most commonly its symptoms are progressive—the milder, such as the affections of the skin and mucous membrane, occurring first; the more severe, as those of the bones and organs, afterwards; but in other cases this progression is not observed, symptoms of great intensity setting in early, without being preceded by those of a slighter kind.

It is extremely difficult to say when syphilis can be eradicated from the system; and indeed it is a question whether it may not impress the constitution in a peculiar way, modifying certain actions during the rest of life, as we know to be the case in other specific diseases, such as cow-pox or scarlet fever. Certain it is that, if neglected or improperly treated, it will affect the system for an indefinite time, declaring its existence by exciting and modifying various local inflammations years after the original absorption of the poison. It is tolerably clear that a person who has once had the usual course of syphilis and has recovered from his malady, cannot have it a second time, though he contract a fresh chancre; and E. Wilson attributes many of the ordinary non-specific cutaneous diseases to the latent influence of constitutional syphilis. This rule is from time to time proved to be generally true by the occasional observation of undoubted exceptions, where repetition of the disease from reinoculation of the virus takes place. But such cases are exceedingly rare, and occur only after an interval of some years has elapsed between the two attacks. [Fournier has described under the name of "*pseudo-chancre induré*," a constitutional symptom which is almost always mistaken for the result of a genuine re-inoculation. (*Archives Générales de Médecine*, Juin et Juillet, 1868.)—A.] Hutchinson has related a very interesting example of this kind in a medical student, who also suffered two attacks of smallpox. Daily experience shows that in many constitutions syphilis cannot be eradicated, and that in most others, when once it has occurred, it is apt, even when apparently cured, to modify certain cutaneous and other affections in a remarkable manner, after a lapse of many years; showing clearly that, if the poison no longer exist in the system, the constitution has re-

ceived a peculiar impress from it, which it is long in losing. These remote effects of syphilis have by Ricord been called *tertiary*. This term is convenient, as indicating a peculiar stage of the constitutional manifestations, in which the tissues are more deeply affected than in the secondary forms of the disease.

Although the disease may continue to modify the system for years, or even for life, yet it seldom proves fatal. In some cases, however, death may occur, either by the cachexy that is induced, by the supervention of phthisis, or by caries of the skull or nodes of the dura mater, and consequent disease of the brain. Fatal and special syphilitic diseases of the lungs and brain have been described of late years with much care, though there still remains a good deal to be ascertained of the relation of syphilis to these changes in the brain and other viscera.

It is especially when the disease has reached the tertiary stage, that it runs so protracted and tedious a course. When the syphilitic manifestations are confined to affections of the cutaneous and mucous surfaces, the disease may, and does occasionally, wear itself out—the *materies morbi* being apparently carried off by the secretions of these tissues; and it is only in this way, I believe, that the affection can be eradicated from the system.

That constitutional syphilis is dependent on the absorption of the syphilitic poison into the blood, and its consequent general diffusion through the system, there can be little doubt. Not only is this rendered evident by the great variety of tissues and organs in which it manifests itself locally, but also in the induction of the peculiar syphilitic cachexy.

Phenomena.—Constitutional syphilis may affect the following tissues and organs, and usually does so in the order in which they are mentioned:—viz., the skin, mucous membranes, periosteum, and bones; the throat, tonsils, palate, eyes, nose, larynx, tongue, and testes.

The first general disturbance of syphilis is often ushered in by febrile symptoms. In proportion to the severity of these, are usually the rapidity of the progress and the extent of the local manifestations. In this febrile disturbance, the nutrition of all the tissues of the body becomes seriously impaired, and the patient acquires a peculiar cachectic look. In other cases the patient gradually falls into a feeble and emaciated condition, becoming sallow and earthy-looking, with loss of hair, and depression of mental and bodily vigor. In this condition not only are the nutritive functions impaired, as is evidenced by his becoming weak and thin, but the reparative actions are lessened, wounds do not heal kindly, and fractures are slow in uniting.

The syphilitic affections occurring on the skin and mucous membranes are usually of a secondary character, though some belong to the tertiary group; whilst those of the bones and different organs, as the larynx and testes, are commonly tertiary. Although the integumental structures are usually first affected, yet it sometimes happens that the disease first attracts attention by its attacks upon the deeper and more important tissues, from the symptoms of its progress on the skin and mucous membranes being entirely overlooked. In women, it is constantly the case for the eruptive stage to be confined to a few mucous patches of the vulva and excoriations of the fauces, the former only of which are sufficiently annoying to attract the patient's attention.

Circumstances influencing Progress.—The severity and manifestations of general disorder which follow the contagion are very various; thus, a widely and long indurated ulcer foretells with few exceptions a long and severe course of syphilis; so, also, a short interval between the appearance of the symptoms of general disorder at the point of contagion will also indicate a severe course of the disease, and a long interval a mild course of the after consequences.

That the *treatment of the primary sore* exercises considerable influence, cannot be doubted. The severity of the course of syphilis is, I believe, materially lessened, and not in any way increased, by a mercurial course, if that course be properly conducted.

The *state of the patient's health* also greatly determines the kind of attack he will have to undergo. If, after the cure of the primary disease, his health continue good, he may almost wholly escape further symptoms of the disease; but if it be broken or cachectic, then secondary syphilis will occur contemporaneously with, or at a very early period after, the primary disease; and, indeed, I generally look upon the chance of the speedy supervention of secondary syphilis as more immediately

dependent on this than on any other cause. It is remarkable for how long a time the syphilitic poison will continue dormant in the constitution without producing any local manifestation of its existence, until this is developed under the influence of a broken state of health. I have had under my care an extremely severe case of constitutional syphilis, in which twelve years elapsed since the occurrence of the primary disease, during the whole of which time no secondary affection was observed until the patient's health gave way from other causes. And I have also had under my care an officer, in whom a very severe form of constitutional syphilis occurred, for the first time, after salivation for hepatic disease, five years after the primary sore had been contracted—no constitutional manifestation having attracted the patient's notice in the meanwhile. Not only does a state of ill-health hasten the occurrence of secondary syphilis, but cachexy, neglect, or indifference to its existence, may keep it up indefinitely.

The question as to there being any connection between the *nature of the primary sore*, and the *character of the consecutive constitutional affection*, has been much discussed; and I agree with Carmichael, that the different forms of primary sore will, if left to themselves, be followed each by its own peculiar train of constitutional symptoms. In fact I am fully convinced, as the result of much and close observation on this point, that there is a general correspondence between the kind of ulcer and the manifestations of constitutional syphilis that may follow it; both, in fact, being chiefly dependent upon the state of the patient's health. The same condition of system, for instance, that will occasion a local chancre to assume the phagedænic or sloughing form, will occasion rupia or ecthyma, with necrosis or caries of the bones, as the constitutional manifestation of syphilis; whereas that which occasions the indurated chancre will equally modify the secondary disease, so that it assumes a squamous form, accompanied perhaps by iritis and periosteal disease; and the soft or excoriated chancre will generally be followed by papular or roseolar eruptions, with mucous tubercles on the tongue or throat. That these sequences are of very frequent occurrence I cannot doubt, having frequently observed them; and that they are not of constant occurrence is, I believe, owing to the character of the constitutional affection being often modified, by the state of the patient's health having undergone a change subsequently to the cure of the primary sore, or to the patient not having been infected with syphilis when he contracted the local sore, and having thus not been rendered liable to constitutional infection. A patient having indurated chancre, will usually get psoriasis as the secondary cutaneous disease; but if he fall into a cachectic state of health between the healing of the chancre and the supervention of the constitutional affection, rupia will manifest itself.

Treatment.—In the treatment of constitutional syphilis, our object is not so much to relieve or to remove any local morbid condition, as to eradicate a poison from the system; and, indeed, the various local manifestations, more especially those that appear upon the cutaneous and mucous surfaces, may possibly be efforts of nature for the elimination of the virus from the system through the medium of the great excretory and emunctory organs; and it is often apparently by aiding this natural action by the administration of those remedies that act upon these tissues, that the poison is most effectually eradicated.

During the continuance of the pyrexia which often ushers in the secondary symptoms, little can be done in the way of specific means for the removal of the disease from the system; rest and mild antiphlogistic treatment being all that can be accomplished during this, the stage of invasion and of constitutional reaction. Great relief is, however, afforded by a few doses of mercury given so as to affect the system. At a later period, when the cachexy which is attendant on the disease has declared itself, attention to the hygienic and dietetic management of the patient is of the utmost importance; a light nourishing diet, often accompanied by the moderate use of wine or beer, and, in some of the lower forms of syphilis in broken constitutions, a general tonic plan of treatment, such as the administration of bark, quinine, or iron, and more especially of cod-liver oil, with the mineral acids and sarsaparilla, are required in combination with the more specific means that we possess for the eradication of the disease from the system. These hygienic and tonic remedies must be administered in accordance with general medical principles, and no special instructions need consequently be laid down for their use here.

The treatment of syphilis is conducted on one of these principles: 1, by the ad-

ministration of mercury, with the view of directly and specifically eliminating the poison from the system; 2, by the preparations of iodine, which are supposed to be specific in a minor degree than mercury in this disease; and 3, by simple attention to the state of the general health, without any attempt at specific treatment. These different principles may be employed simultaneously or consecutively. As a general rule it may be stated that, the longer the interval that separates the constitutional from the primary symptoms, the more they partake of a *tertiary* character, the less necessity will there be for specific treatment, and the more important will be the employment of all means calculated to improve the health.

Of the value of *mercury* in constitutional syphilis, every surgeon of experience must have had abundant proof. It may admit of doubt whether mercury can be justly considered as exercising a *specific* action, as there are some cases of the disease that it certainly does not appear to influence in a beneficial manner, and others the severity of which is certainly increased by the administration of this remedy; but it appears to me that in these cases it is rather the patient's constitution, which does not bear the remedy well, than the disease that is at fault. We know that in many states of the system, and in many individuals unaffected by syphilis, mercury acts injuriously, more especially when anything like cachexy is present; and we cannot but suppose that the same injurious influence on a particular habit of body must continue, though it be contaminated with the poison of syphilis. The best proof that we possess of the influence of mercury over constitutional syphilis—an influence, indeed, that almost approaches to the nature of a specific action—is in the case of infantile syphilis; here mercury will not only cure the disease, but will eradicate the virus from the system in a way that no other remedy can accomplish.

In the treatment of constitutional syphilis with mercury, everything depends on the proper administration of the remedy at a suitable period of the case, and in a fitting condition of the constitution. The question as to the propriety of the administration of mercury in constitutional syphilis, the particular preparation to be used, and the period of the disease in which it should be given, must be determined in a great measure by the previous treatment of the primary disease, by the condition of the patient's general health, and by the duration of the secondary symptoms. If mercury have been freely given, perhaps in repeated, irregular, and ill-conducted courses, for the cure of the primary affection; if the patient have fallen into a cachectic state, having lost flesh, color, appetite, and spirits; if the constitutional affection have assumed the tertiary form, and have deeply implicated the bones, mercury should not be given at all; or, at all events, not without proper previous preparation. In these circumstances, I think we should endeavor, if possible, to remove the constitutional affection without mercury. It is true that in many cases we shall not succeed in doing so; but at least we improve the health, check the disease, and bring the patient into a proper condition to support a mercurial course, should it be thought necessary eventually to subject him to one. It is in these conditions of the system that the *nitro-muriatic acid* and *sarsaparilla* are of much service. From twenty to thirty minims of the dilute acid, with half an ounce of the fluid extract of sarsaparilla in four ounces of water, may be administered three times a day. To this the *iodide of potassium*, in five-grain doses, may often be advantageously added; or this salt may be given alone in some bitter infusion, as of cascarilla, quassia, or bark; or, if the patient be in a very cachectic and emaciated state, in cod-liver oil. The *iodides of sodium* and of *ammonium* have also been highly spoken of, especially by some Italian practitioners, in the treatment of constitutional syphilis. In the more advanced cases of the disease, when it has assumed the tertiary form, and the constitution is much broken and the patient anæmic, the preparations of *iron* may be given with much advantage. When there is great emaciation, I have found the combination of the iodides of potassium and of iron with cod-liver oil, or the potassio-tartrate of iron in sarsaparilla, to be especially beneficial. But useful as these remedies, especially iodide of potassium and the dilute mineral acids, unquestionably are, more especially when administered in the compound decoction of sarsaparilla, I do not believe that they exercise any specific influence on the disease, or that they do more than relieve or remove local manifestations, often of a troublesome and disfiguring character; failing altogether to cure the constitutional affection and to eradicate the virus from the system, for which purposes mercury will at last be required. Their great utility appears to consist in removing cachexy, and in restoring the vigor of the nutritive and reparative actions,

which are in abeyance; and, by improving the general tone of the system, in enabling it to resist more effectually the advance of the disease, and in some cases, perhaps, to allow this to wear itself out. That great advantage results from maintaining the tone of the system in syphilis, is undoubted; we always find that the intensity of the ravages of the syphilitic poison is in direct proportion to the debility and want of resisting power in the constitution of the patient. Besides being useful in this way, these remedies are often of service in removing local affections, and in repairing the injury inflicted upon tissues and organs by the low and specific inflammation that is set up in them. In this respect, indeed, more particularly in its advanced or tertiary stages, when the specific nature of the disease is to a great extent worn out, and little remains but to correct the cachexy and mal-nutrition that have been left as the result of long continued ill-health, nothing can exceed the value of these remedies in constitutional syphilis. I do not, however, believe, that the disease can be eradicated from the system by these means, or that any of these remedies, even the iodide of potassium, can take the place of mercury in the treatment of constitutional syphilis; indeed, I cannot call to mind a single case in which this form of the affection has been radically and permanently cured without the administration of mercury. Those cases in which they exercise most beneficial influence, are certainly instances in which mercury has been injudiciously administered, either for the primary or the secondary disease, and in which the powers of the constitution have in this way been sapped. In these circumstances, a course of the iodide of potassium, of the mineral acids, or of the potassio-tartrate of iron in sarsaparilla, should always be administered, with a view of improving the patient's general health.

Looking, therefore, upon *mercury* as the only remedy we possess that influences directly and permanently the venereal poison, I think that it should always be administered in a full course during some period of the treatment of constitutional syphilis. The time at which it should be given is of considerable importance; thus, it is usually better not to administer it until the initiatory pyrexia has subsided under the use of ordinary antiphlogistic treatment; nor should it be given if there be a very marked cachexy. After this has been removed, however, by other means, the employment of mercury may be proceeded with.

In administering this remedy for constitutional syphilis, we must not give it largely, so as to affect the system rapidly, but as a mild course for some weeks, so as to act freely upon the secretory and excretory organs, and thus to eliminate the poison from the system. The most useful preparations are the bichloride, in doses from the twelfth to the eighth of a grain; or the iodide in one-grain doses three times a day. These should be given with sarsaparilla, which keeps up the power of the system and acts freely upon the kidneys and the skin. The mercury should be continued for at least from three to six weeks, until a decided improvement has taken place in the constitutional symptoms. I do not think it desirable to produce salivation; all the good effects of mercury can be obtained far short of this; and, indeed, if the remedy be pushed to such a point as to affect the mouth or gums, it will commonly act injuriously, by depressing the powers of the system too much. I therefore think it well to suspend its administration whenever an impression has been made upon the disease, and before its depressing effect has been produced. The cautions necessary during the mercurial course, when administered in secondary syphilis, are precisely similar to those that we have described as necessary during the primary treatment of the disease.

In some cases of constitutional syphilis, affecting the skin and more superficial structures, mercury may conveniently be administered by *fumigation*. This plan of treatment, which has been especially recommended by Langston Parker and H. Lee, consists of a combination of vapor-bathing and of mercurial fumigation; and these gentlemen speak in the highest terms of the value of this remedy in syphilis, as shortening the duration of ordinary treatment, and permanently curing the disease without the constitution of the patient being in any way injured by its employment. The baths may also be associated with appropriate internal treatment. During the use of the fumigations, the patient should be dieted, and be put on a full course of sarsaparilla. The bath may be administered every second day, and should consist of about a drachm of cinnabar slowly volatilized by means of a spirit-lamp, at the same time that steam is disengaged from boiling water. In this way I have for some time past used fumigations at the hospital and in private

practice, and with very great success, in cases of syphilitic cachexy with extensive cutaneous disease of an ecthymatous or rupial character, in constitutions in which mercury could not be borne in any more active form. H. Lee prefers calomel as the material to be volatilized, twenty or forty grains being used on each occasion.

Whatever plan of treatment is adopted, it should be carried out for a sufficient length of time; great evil often resulting by intercepting it too suddenly, and being contented with the removal of the local mischief, whilst the disease is left firmly seated in the constitution.

Local Secondary Affections.—We shall next proceed to consider the character and treatment of the different *local forms* in which constitutional syphilis manifests itself. These may be considered as they affect different tissues and organs, and require separate consideration, according to the part that is influenced by them. We shall consider them as affecting the skin; the mucous membranes of the mouth, nose, tongue, palate, larynx; the eye, bones, testes, and muscles.

1. *Syphilitic Affections of the Skin.*—Syphilo-dermata or syphilides present various modifications of appearance, corresponding very closely to the different groups of idiopathic cutaneous diseases; thus we find exanthematous, papular, squamous, vesicular, pustular, and tubercular syphilitic affections of the skin, with various ulcers and growths. These differ from the corresponding simple cutaneous diseases, in their redness being more dusky or coppery, in leaving stains of a brownish or purplish hue, in their outline being circular, and in their crusts or scabs being dark, blackish, thick, and rugged-looking. Besides this, syphilis modifies materially the general character of the cuticle, causing it to assume a yellow or earthy tint, and to be rough or powdery. The worst forms of these affections are commonly met with on the face and more exposed parts of the body.

Syphilitic skin-diseases arrange themselves under the following groups:—

The *roseola* consists of blotches of a reddish-brown or coppery tint, which become more distinct as the redness declines; they vary in size from small circular spots to large and diffused patches. These are usually first observed about the abdomen, and commonly occur early in the disease, often before the primary sore is healed. Syphilitic roseola usually occurs in patients who have had chancrous excoriation, and is very frequently accompanied by an erythematous condition of the throat.

The *squamous* syphilide occurs in small patches of an irregular shape, of a red and somewhat coppery color, which are commonly covered with thin filmy scales. In many instances the patches are, however, quite smooth, so as to have a glazed and almost shining look. They are usually situated on the inside of the arms and thigh, often on the scrotum and penis, even occurring on the glans. They also frequently appear on the palms and soles, where deep fissures and cracks are met with. About the lips, the squamous syphilide gives rise to deep and troublesome fissures. It is often associated with a deep and excavated ulcer of the tonsils, with inflammation of the iris, and not uncommonly with disease of the periosteum and bones, and almost invariably follows the indurated chancre. Associated with this condition are large brown patches or maculæ, which occur on various parts of the body.

The *vesicular* syphilide is of very rare occurrence. In one case which fell under my observation, it appeared in the form of clusters of small pointed vesicles, which, on drying, left gray or brownish crusts and coppery marks.

Syphilitic *pustules*, on the contrary, commonly occur; beginning as small hard papulæ of a coppery hue, slowly softening in the centre into a small deeply-seated pustule, having a large brown or coppery areola, and forming speedily large circular dark-brown or even black scabs; usually flat and irregularly crusted, at other times conical. When flat, they constitute syphilitic ecthyma; when conical, the rupial form of the disease. After their separation, troublesome ulcers of a circular shape, and with rather a foul surface, are commonly left. This disease first appears upon the face, but speedily shows itself on various parts of the body, more especially on the extremities; it is always indicative of constitutional cachexy, and often appears at an early period after phagedænic chancre; when it follows other forms of chancre. this is, I believe, owing to the system having in the meantime fallen into a low and broken state.

Syphilitic *tubercles* commonly occur as an advanced or tertiary symptom; they

appear as hard, smooth, flat, and elevated bodies of a reddish-brown or purplish color, seated on the face, the tongue, the limbs, the penis, or the uterus. They may be resolved by proper treatment, but have a great tendency to ulcerate and to destroy the parts on which they are situated, giving rise to large, deep, foul, and serpiginous sores.

Syphilitic *boils* of an indolent character, but painful, and discharging a thin ichorous pus, with a core of shreddy areolar tissue, and leaving deep, irregular, and foul ulcers, are not uncommonly met with.

Syphilitic *ulcers* may result from pustules, tubercles, or boils, or may commence as tertiary sores; they frequently occur where the integuments are thin, or where they are moistened by the natural secretions of the part. They are circular, with elevated edges, and tend to spread in circles, with a foul grayish surface; often creeping along slowly, and destroying deeply the parts they affect; leaving cicatrices of a bluish or brown color, thin and smooth, which are apt to break open again on the application of any slight irritation.

The *hair* and *nails* are commonly affected in advanced constitutional syphilis; baldness, constituting *syphilitic alopecia*, occurring either generally or in patches, without any apparent disease of the skin. Disease of the nails, *syphilitic onychia*, occurs in two forms, either as a foul ulceration between the toes, or else as a chronic inflammation, with fetid discharge in the matrix of the nail; which becomes black, more or less bent, and scales off with the formation of a dirty ulcer under its detached edge.

The *treatment of cutaneous syphilis* must be conducted in accordance with the general principles already laid down, and with special reference to the characters of the concomitant constitutional condition, or of the other local manifestations accompanying it. In the early stages, when ushered in by febrile disturbance, a mild antiphlogistic treatment is required; when the pyrexia has been subdued, more specific measures must be had recourse to. In the *roseolar* forms, the treatment of the secondary affection should be guided by the previous management of the primary sore. If mercury have been given for this, we should content ourselves with the iodide of potassium in infusion of quassia, or, what is better, in full quantities of the compound decoction of sarsaparilla. Should mercury not have been given in the primary sore, recourse must now be had to it. In the *squamous* syphilide, mercury, I think, is always necessary; and here I give the preference to the iodide over the other preparations. In the *pustular* forms, syphilitic rupia and ecthyma, the constitution being commonly shattered, a tonic plan of treatment is required in the first instance; after which the bichloride of mercury in tincture of bark or decoction of sarsaparilla should be steadily administered. In these cases also much benefit will be derived from the mercurial fume-bath. In the *tubercular* syphilide much the same treatment is required as in the last variety; in these cases, however, I have often found Donovan's solution of the greatest possible value, the disease rapidly disappearing under its use; the same plan is required in the management of syphilitic *boils*. In the treatment of secondary syphilitic *ulcers* we shall find it necessary to use caustic freely, with the view of setting up a new and more healthy action in the part. For this purpose nitric acid, or the acid nitrate of mercury, is especially serviceable; on the separation of the slough thus produced, the sore may be dressed with red precipitate powder or ointment, or the black wash, to which, if there be irritation, opium may be added—the same constitutional treatment, especially Donovan's solution, being employed. In syphilitic *alopecia*, the internal administration of bichloride of mercury with bark or iron, and the external use of a strong stimulant, such as the nitrate of mercury ointment or tincture of cantharides, will be found most serviceable; and in syphilitic *onychia*, the free application of nitrate of silver, followed by the black wash, and bichloride of mercury or Donovan's solution internally, is the proper treatment.

2. *Warts*, *excrescences*, and *vegetations* are commonly met with in constitutional syphilis, especially in the neighborhood of the mucous canals, being usually situated in the neighborhood of the anus, perineum, or scrotum; and in the female, upon and within the labia. They are also very frequently met with about the tongue, on the tonsils, palate and lips. When occurring in the neighborhood of the organs of generation, they are usually large, flat, soft, slightly elevated, and uniform in structure and appearance, moistened with a good deal of mucous exudation, and a sort of perspirable secretion of the neighboring skin. When seated in the mouth or

throat they are usually small, and not so distinctly elevated or circumscribed, but look rather like a thickened and opaque condition of the mucous membrane in these situations. These secondary warts, *condylomata* or *mucous tubercles*, as they are often termed, differ essentially from the primary vegetations, not only in their appearance and general uniform character, but in being dependent on the constitutional condition of the disease, and not on local causes solely, such as the irritation of discharges and the want of cleanliness. They are also certainly contagious; and I have known many instances in which they have been distinctly transmitted in this way; and, indeed, it is by and through them that secondary syphilis is transmitted from one individual to another, without the evidence of an antecedent primary sore. Their *treatment* must be constitutional as well as local; the constitutional means should consist in the administration of the bichloride of mercury with sarsaparilla; and the best local treatment with which I am acquainted is to rub them freely with the nitrate of silver, dressing the parts in the interval of the application with chlorinated lotions. Not being pendulous or distinctly protuberant, they do not, like the primary excrescences, require excision.

3. The *mucous membranes of the mouth*, *nose*, *pharynx*, and *larynx*, are commonly affected with secondary syphilitic eruptions; these assume the form of mucous tubercles, or of the exanthematous, tubercular, and ulcerative syphilides. The *exanthematous* affection, corresponding to the roseolar form of cutaneous syphilis, and arising from the same cause and in the same constitution, principally affects the palate and throat. The *tubercular* variety corresponds to the squamous cutaneous eruptions, and is chiefly met with as flat, hard, and elevated tubercles in the interior of the mouth, nose, and throat. The *ulcerative* affection of the mucous membranes assumes a variety of forms, which will immediately be described, and occurs principally in the throat and nose. The exanthematous affection of the mucous membrane is usually an early sign of constitutional syphilis, frequently showing itself a few weeks after the primary occurrence of the disease. The other varieties belong to the more advanced secondary or tertiary periods.

The syphilitic affections of the mucous membranes so readily extend to, and are so commonly associated with, corresponding disease of the deeper structures, that we shall more conveniently consider their different forms according as they affect distinct organs or parts of the body.

The *lips* are commonly affected in persons laboring under squamous syphilide, with fissures or cracks usually somewhat indurated, and very painful in the movement of these parts. In the *treatment* the application of a pointed piece of nitrate of silver to the bottom of the crack will give the most effectual relief. The insides of the cheeks are not unfrequently affected in a similar manner, or become the seat of mucous tubercles, which must be treated as has already been stated.

The *tongue* may be affected with syphilis in various forms; when severely, its disease usually constitutes one of the tertiary varieties of the affection. In many cases the mucous membrane becomes thickened, but preserves a peculiar glossy, semi-transparent, almost gelatinous appearance, and, being irregularly fissured, gives the organ a thick and misshapen look. In other instances, the epithelium is dry, white, and opaque in patches; the surface of the tongue looking as if it had been dyed white here and there. Occasionally, ulcers form upon its surface or sides; these are usually irregular in shape, with a foul surface and a good deal of surrounding induration, and unless care be taken, may readily be confounded with scirrhus or epithelial cancer of the organ. The diagnosis of these affections we shall consider when speaking of diseases of the tongue generally. Occasionally a hard elevated circumscribed tumor of a dark red or purplish color slowly forms towards the centre of this organ; it increases without pain and in a gradual manner, and principally occasions inconvenience by its bulk and the impediment it occasions in the movements of the tongue. These various diseases usually indicate a deeply seated constitutional affection of the tertiary type. But some of the most obstinate cases that I have met with appeared to have originated from direct contact of the tongue with the same organ in another person the subject of tertiary lingual syphilis, and thus in direct contamination. The *treatment* consists in the administration of mercury, either in the form of iodide or of bichloride. Donovan's solution is extremely useful in many of the more inveterate of these cases. The ulcers should be touched from time to time with the nitrate of silver.

The syphilitic diseases of the *throat* are amongst the most common manifesta-

tions of constitutional syphilis, and frequently occur early. They present several distinct forms, corresponding to analogous primary and secondary cutaneous affections. One of the earliest conditions is a deep red exanthematous efflorescence of the soft palate and the pillars of the fauces, either without ulceration, or with but superficial abrasion, but with much cachexy and depression of power and perhaps with considerable pyrexia. It often occurs about the period of the invasion of the roseolar or rupial syphilide, and requires the same *treatment* as is necessary in these affections, together with the local application of a strong solution of the nitrate of silver. A deep excavated ulcer, with a hard base and foul grayish surface, of circular or oval form, is not unfrequently met with on one or the other tonsil; it corresponds to that class of secondary phenomena that follows the indurated chancre, and requires mercury in some form for its cure; in this and many other cases the mineral may most conveniently be applied to the throat by means of fumigation. A sloughing ulcer is occasionally seen on the side of the throat or palate, with much swelling, a foul gray surface, and rapid destruction of parts, giving rise very commonly to perforation of the soft palate, and thus, by partially destroying the curtain between the mouth and the nose, occasioning serious inconvenience to the patient during deglutition and in speech. This form of ulcer is connected with the rupial or ecthymatous syphilides, and requires the same *constitutional treatment* as these. The best *local* plan is free sponging with strong nitric acid, and gargling with solutions of the chlorides. More rarely a form of the serpiginous ulceration is met with, producing considerable contraction and inconvenient consolidation of tissues after its cure. It is, I think, best treated by the local application of nitric acid, and the internal administration of bichloride of mercury.

The mucous membrane of the *larynx* is not unfrequently affected both in early and in advanced syphilis. During the period of the scaly eruptions on the skin, and excoriation of the fauces, the larynx is attacked by catarrhal inflammation and by the formation of flat slightly elevated papules, similar to those seen on other parts of the body. The symptoms are hoarseness and loss of voice, and occasionally cough. They usually subside without leaving any permanent injury. In these cases, chronic inflammation, with thickening and ulceration, takes place about the rima glottidis, with the general and local symptoms of chronic laryngitis; such as huskiness of voice, cough, and expectoration of tenacious or offensive mucus; a difficulty in deglutition, and a tendency to choking on swallowing liquids, with tenderness on pressure about the throat, also come on. These cases are usually accompanied by much constitutional cachexy, and not unfrequently eventually terminate fatally by the sudden supervention of œdema glottidis. The *constitutional treatment* must depend upon the concomitant symptoms and the general state of the patient; most commonly tonics will be required. The *local means* consist in the free application of the solution of the nitrate of silver to the rima glottidis, and the occasional employment of counter-irritation. In syphilitic ulceration occurring about the sides or base of the epiglottis, care must be taken in the application of the stronger escharotics, such as nitric acid, or the acid nitrate of mercury; as a small quantity of these, if inhaled into the larynx, might produce serious difficulty in breathing, or even fatal asphyxia. In many cases it may become necessary to open the windpipe, in order to prevent the patient from dying of asphyxia; this must be done in accordance with the rules that will be laid down when treating of chronic laryngitis.

The *nose* is commonly affected in constitutional syphilis, and often destructively so, especially in individuals much exposed to changes of temperature, and who are unable to pay proper attention to their treatment. The mucous membrane becomes chronically thickened, with discharge of blood and pus, coryza, and habitual snuffling. In other cases ulceration takes place, with a very fetid odor of the breath, and the formation of thick ecthymatous crusts on the septum, or between this and the alæ. This ulceration is of a very persistent and troublesome character, and requires usually a mercurial treatment with the local application of strong nitric acid, or of the acid nitrate of mercury, to arrest its progress. In many cases ulceration will rapidly proceed to destruction and perforation of the septum, or necrosis of the spongy bones, the vomer, and ethmoid; sometimes excavating the whole of the interior of the nose, scooping and cleaning it out into one vast chasm. When this happens the nasal bones are usually implicated, being flattened, broken down, and destroyed; the alæ and columna ulcerating away, and producing vast disfigurement.

Occasionally the disease extends to the bones of the base of the skull, and in this way may occasion amaurosis, epilepsy, or death. The *treatment* of these nasal affections must be conducted in accordance with general principles. In many cases mercurial fumigation is extremely useful; in others, where the disease is of an ulcerative character, the strong acid and caustic applications already mentioned, with chlorinated solutions occasionally sniffed up, will do much to stop the progress of the disease. As necrosis occurs, the dead bone must be removed.

4. *Syphilitic iritis* usually occurs after exposure to cold, and often in people that are otherwise strong and healthy. The ordinary symptoms of iritis, somewhat modified, characterize the affection. The patient complains of dimness of sight, pain in the eye, and often of very severe circumorbital or hemicranial pains. On examining the eye, the conjunctiva will be found to be slightly injected, and a zone of pink vessels to be seated on the sclerotic, close to the cornea; the aqueous humor has lost its transparency, giving a muddy look to the eye, and the color of the iris is altered. The pupil is irregular in shape, usually angular towards the nasal side, and small yellowish or brownish nodules of lymph may be seen to be deposited on the surface of the iris. If the case be left to itself, or be improperly treated, it will advance to disorganization or to permanent opacity of the eye.

The *treatment* of these cases consists in local depletion by means of cupping and leeches to the temples, and the administration of calomel and opium internally, at the same time that a drop of the solution of atropine is put into the eye. Most commonly, as the mouth becomes affected by the mercurial, the eye will clear, the lymph becoming absorbed, and the pupil regaining its normal shape and color. In some cases, however, a chronic inflammation continues; in these circumstances, the best effects result from the administration of small doses of bichloride of mercury, with repeated blistering to the temples; and, in a later stage, soda and bark may be advantageously given.

[Syphilitic iritis may be safely and efficiently treated by the free use of atropia, and the internal administration of the oil of turpentine, in doses of a fluidrachm three times a day. This remedy, which was originally proposed by Mr. Carmichael, may occasionally be aided in its action by the simultaneous exhibition of the iodide of potassium.—A.]

5. *Venereal periostitis* or *nodes* may occur on almost any of the bones; but the disease is most commonly met with on the tibia, the clavicle, or the bones of the forearm. Some joints are also not unfrequently affected by it; the sterno-clavicular articulation and the knee-joint are especially often its seats.

Nodes are indolent, elongated, uniform, and hard swellings, sometimes tender on pressure, and generally but little painful during the day; but at night the aggravation of pain is peculiarly marked, and constitutes perhaps the most distressing symptom in these cases. They consist of a thickened state of the periosteum, with some plastic effusion within and underneath it, and occasional thickening of the subjacent bone; they may continue permanently or may terminate by resolution; it is seldom that they suppurate, unless there be disease of the subjacent bone. The *treatment* consists, if there be much tenderness, in the application of leeches; if there be no great sensibility on pressure, but considerable nocturnal pain, blisters should be applied. When they are in a chronic state, the tincture of iodine is an useful application. Nodes sometimes become soft and prominent, and feel semi-fluctuating, especially when seated on the cranium, so as almost to tempt the surgeon to make an opening into them; this, however, should never be done, as the swelling, however great, will subside under proper treatment. For the ultimate removal of the tumor, and the relief of the nocturnal pains, we possess an excellent and sure remedy in the iodide of potassium.

Other fibrous membranes besides the periosteum may become diseased in constitutional syphilis, and masses of dense lymph in the form of warty tumors, excrescences, or nodes, may be deposited upon them as the consequence of the specific inflammation. This is particularly the case with the dura mater. As one of the ulterior effects of tertiary syphilis, structural changes of this kind may take place in and upon it, giving rise to epileptiform seizures, and eventually coma and death, partly from pressure, partly from irritation.

6. *Diseases of the bones* are amongst the more remote and severe effects of constitutional syphilis, when it has reached the tertiary stage. By some surgeons they are said to be the result of the administration of mercury, rather than of the syphi-

lis for which the mineral is given. This doctrine I believe to be entirely without foundation. I have had under my care patients with extensive disease of the cranium and of the clavicle, whose syphilis had been treated from first to last on the non-mercurial plan. One patient especially, a soldier, from whom I removed a portion of the cranium and of the clavicle for necrosis accompanying constitutional syphilis, had been treated in a military hospital without mercury. I have never seen or heard of mercury producing necrosis in any bones, except those of the jaws, when given for other diseases than syphilis. No doubt such diseases of the bone are especially apt to occur when the patient's constitution has been broken down by any means; and an improperly conducted mercurial course may be one of these. That they are met with in syphilitic cases in which no mercury has been given, there can be no doubt. They usually occur after the patient has passed through the whole course of the less severe syphilitic affections, such as those of the skin, mucous membrane, and throat. The affections of the bones, however, are not necessarily preceded by the minor constitutional effects, but may in some cases declare themselves at the same time with the affections of the skin and mucous membranes. They more commonly occur amongst the poorer classes, especially those who are exposed to atmospheric vicissitudes, and chiefly in strumous constitutions.

The venereal affections of the bones are principally met with in those that are flat and compact, as the cranial, nasal, and maxillary bones. In these, various forms of disease occur. One of the most common is perhaps *chronic osteitis*, with hypertrophy and condensation of the osseous tissues, often to a very marked extent. This affection may occur in the bones of the skull, but is also met with in some of the long bones, as the tibia and the ulna; it is characterized by very severe pain, especially of a nocturnal character, accompanying the enlarged and thickened state of the bone.

Syphilitic necrosis chiefly occurs in the bones of the skull and jaws, the alveolar processes of which may exfoliate; the palatine process of the superior maxillary bone, the spongy and the nasal bones, are also commonly destroyed by this morbid action; but it is a remarkable fact that the palate-bones are not nearly so often affected as the nasal and spongy bones. In consequence of this destruction of bony tissue, the interior of the nose becomes chronically diseased, and the organ may fall in, or a communication may be established between the nose and the mouth through the hard palate.

Syphilitic caries, or ulceration of bone, presents different forms, which, according to Stanley, correspond to analogous ulcers and eruptions of the skin. Thus, there may be the *simple ulcer* of the bone, showing a rough, irregular, porous, and depressed surface; *the worm-eaten caries*, consisting of small pits or excavations, studding the surface; and the *serpiginous* or *creeping ulcer*, marked by imperfect attempts at repair, and the deposition of new bone in nodules or masses. The cranial bones are those that are most commonly affected in this way; and their disease may sometimes prove fatal by the irritation set up by it in the brain or its membranes. The bones of the extremities, however, are not unfrequently similarly affected.

I have twice seen a peculiar *dry caries* of the cancellous structure of the head of the tibia in old syphilitic cases. In both cases, which were very similar, the patients had been affected for a length of time with nodes of the tibia, as a consequence of long-antecedent syphilitic taint. Chronic abscess eventually developed itself over the head of the tibia, leading to carious bone. I exposed and gouged this away. It was peculiarly dry, light, and almost flocculent, if such a term can be applied to bone. Both patients recovered well from the operation; but one of them, a female, died two years afterwards of epilepsy, consequent on syphilitic tumors of the dura mater.

The *treatment* of syphilitic caries varies somewhat, according to the form which the disease assumes, and the previous management of the patient. In *osteitis*, the principal reliance should be placed upon the conjoined influence of calomel and opium, provided the patient have not previously been fully mercurialized. If he have been so, we must rely chiefly upon iodide of potassium. In the more advanced and intractable cases that have resisted all treatment I have found the greatest advantage result from cutting down upon the enlarged, thickened, and tender bone, and by means of a Hey's saw making a deep cut into it about one and a half or two inches in length, parallel to its axis, and down to the medullary canal. By this

operation the tension is at once relieved, and the pain effectually and permanently removed. In syphilitic *necrosis*, the constitutional cachexy demands the principal share of attention; the necrosed bone should be separated as it becomes loose, the local irritation depending on its presence then subsiding. When the bone has fallen into a *carious* state, iodide of potassium in combination with iron, cod-liver oil, or sarsaparilla, with the mineral acids, will improve the tone of the system, and stay the progress of the disease. The ulcerated and exposed bone requires to be dressed with strong stimulants; the red oxide of mercury, in ointment or powder, is perhaps the best; in some cases, touching the part freely with the acid nitrate of mercury will establish a more healthy action.

6. Syphilitic disease of the *testicle* is one of the more advanced conditions of the constitutional affection. It commonly occurs as the result of that train of symptoms that consist mainly of squamous affections of the skin, the excavated ulcer of the throat, iritis, and nodes, but usually it does not appear until these different manifestations of constitutional syphilis have each in their turn passed away; the patient, indeed, appearing to have recovered from all disease, and being otherwise in good health. Commonly the exciting cause of the disease may be a blow, a squeeze, the occurrence of gonorrheal epididymitis, or some other local cause. The testis will then be observed gradually to enlarge, until it attains the size of a turkey's egg, or even larger, being ovoid in shape, heavy, and smooth, not painful except by its weight, which causes dragging and uneasy sensations in the cord and loins. This disease is very commonly accompanied by a small hydrocele, constituting, indeed, a hydro-sarcocele. Most frequently only one testis is affected; it is but very rarely that both are diseased. The affection continues to increase, giving rise to uneasiness from its size and weight, but is not followed by suppuration or other inconvenience.

Hamilton of Dublin has described another form of syphilitic sarcocele, under the term "tubercular syphilitic sarcocele." In this the testis is enlarged to three or four times its natural bulk, of an irregular shape, presenting an uneven, hard, and knotty mass; it is neither painful nor tender, but inconvenient from its weight, causing pains in the loins and cord. Both testes are usually affected, but one is worse than the other; and when the disorganization is great, Hamilton states that all sexual desire is lost, and that neither erections nor emissions take place; both, however, returning as the treatment effects the restoration of the organ to its normal condition. In these cases suppuration not unfrequently takes place, followed by the discharge of thin pus, the formation of fistulous openings, and occasionally the protrusion of a fungus. This form of sarcocele occurs in persons of a broken and cachectic constitution, who are suffering severely from the more advanced and inveterate forms of tertiary syphilis, especially of the bones and throat.

In the simple syphilitic sarcocele, the enlargement of the testes is principally due to the deposit of semi-transparent white or yellow lymph, in an uniform manner, throughout the substance of the organ external to the tubuli. In the tubercular syphilitic sarcocele, Hamilton states that tubercles of a yellow color, and varying in size from a split pea to a chestnut, or even larger, are found in the substance of the organ; these, softening, give rise to suppuration in and around them, and thus to the ultimate disorganization of the testis, which becomes converted into a hard irregular fibro-cellular mass, in which cretaceous matter is occasionally deposited.

In the *treatment* of the simple form of sarcocele, a full mercurial course is generally necessary; the bichloride, in doses of the twelfth or eighth of a grain three times a day, is the best preparation. This should be continued for at least six or eight weeks, or until hardness disappears. Any hydrocele that exists should be tapped, and the fluid drawn off by means of a small trocar and canula before the treatment is commenced. After the mercury has been discontinued, the remaining swelling of the testis may be removed by the internal administration of iodide of potassium in five-grain doses, twice or thrice daily, with frictions with the iodide of lead ointment. In these cases, care should be taken not to irritate the scrotum with very stimulating applications, as the skin is tender, and readily becomes excoriated; ordinary strapping is of very little use, but in some cases I have found strapping with the plaster of ammoniacum and mercury, diluted with equal parts of belladonna plaster, of service. If suppuration occur, and a fungus protrude, the same treatment must be adopted as will be described when we come to speak of the strumous testicle.

7. *Syphilitic ovaritis* is a disease that I believe I have on several occasions met with. The history of the cases has been uniformly as follows: a long antecedent attack of syphilis; various constitutional symptoms running through secondary and tertiary stages; inflammatory congestion of one ovary, as determined by abdominal and rectal exploration; eventual cure by means of leeching and the bichloride of mercury and bark;—in fact, a condition of things closely resembling what occurs in syphilitic sarcocele.

8. Besides these various constitutional manifestations of syphilis, tumors of the *muscles and tendons*, depending on this disease, have been described by Bouisson. These consist of nodules of yellow gummy matter, like those described to occur in the testis; they form between the muscular fibres from the connective tissue. The muscles are also often contracted by tough adhesions of the sheaths and insertions through slow inflammation and thickening of the fibrous tissue. When affecting the tendons, these tumors are elongated, and resemble nodes upon them. Their presence is attended with some pain during the contraction of the muscle; they are usually somewhat globular, and vary in size from a nut to a pigeon's egg, being accompanied by nocturnal pains. They are best treated by the iodide of potassium.

INFANTILE SYPHILIS.

The existence of a chancre on the labia of the mother may possibly infect the child at birth with either of the two forms of venereal disease that have been described, just as it may inoculate the hand of the accoucheur; but syphilis thus contracted by the infant is not the form of the disease that is described as *infantile syphilis*. This is a truly hereditary infection, transmitted to the infant at the time of its conception, or communicated to it through the medium of the mother during intra-uterine life, and existing as a constitutional affection at the time of its birth. Though we may believe that syphilis is not easily eradicated from a system into which it has once been received, and that under certain conditions it may readily be transmitted to the offspring; yet I think that we are still ignorant of the amount and nature of the constitutional affection of the parents that are necessary for the development of syphilis in their children, and that we are certainly not warranted in concluding that a parent who has been, or even who is actually affected by constitutional syphilis, must necessarily have a syphilitic, or even a feeble and strumous family; although the probability undoubtedly is that the former will be the case. I have had under my own observation a gentleman whom I had attended for secondary syphilis, and who, contrary to my advice, married a few years ago; and, though he has since then suffered from psoriasis of the hands, mucous tubercles, fissures on the lips and tongue, and venereal sarcocle, yet his wife has borne a perfectly healthy family, not only without any syphilitic taint, but without any apparent constitutional cachexy.

Syphilis, when transmitted by the parents, appears to lessen the vitality of the ovum to such a degree, that it either cannot reach its development, or, if it do so, that the child which is born is not only tainted, but enfeebled in constitution. When the ovum is infected with syphilis, several morbid states may result, according to the intensity of the infection. It may be so blighted that it never reaches the maturity of intra-uterine life, but becomes early aborted; in this way many miscarriages may happen in consequence of one or both of the parents having constitutional syphilis; but, if they be put under proper treatment by a mercurial course, and the disease be thus eradicated from the system, the ovum will at the next pregnancy probably reach its full development. The embryo may go its full time, and the fœtus be born with syphilitic cachexy and local manifestations of the disease fully developed upon it. More frequently, however, it happens that the child, although cachectic and sickly looking, is brought into the world without any syphilitic appearances; but in the course of a few weeks, usually from the third to the eighth, these declare themselves. Constitutional syphilis of a congenital nature may manifest itself even at the adult age. This, though rare, has fallen under my observation in a young woman of seventeen who was covered with marked syphilitic psoriasis, with which she had been affected for several years. The mother told me that, shortly after birth, evidences of infantile syphilis had appeared; that these had yielded to treatment, but that, as the period of puberty approached, the psoriasis, which was truly of a syphilitic nature, had shown itself. In other cases, again,

it is not impossible that the syphilitic taint may manifest itself in a different way from that which has just been alluded to; that no local manifestation may occur, but that an impaired and depraved state of constitution and of nutritve activity may be inherited, which, in after-life, gives rise to some of the various forms of scrofula or of other constitutional disease, dependent upon an enfeebled state of system, or a diminution, as it were, of the general vitality.

Mode of Communication.—The mode of communication of syphilis to the ovum, or to the intra-uterine fœtus, is an investigation that has much occupied the attention of surgeons, and is of considerable practical interest. It has been considered probable, that the poison may be communicated to the embryo in at least four ways: *viz.*, 1, the father may have a constitutional taint of which he has been imperfectly cured, and, without communicating any syphilitic disease to his wife, may be the parent of an offspring that exhibits indications of being infected; or, 2, the mother, having a similar constitutional disease, may in like manner taint her own offspring; or, 3, the diseased child may be born of parents, both of whom are constitutionally infected; or, 4, the mother may become pregnant with a healthy embryo, but, afterwards contracting syphilis, may transmit it to her offspring.

There are very good reasons for doubting if the disease passes from the father to the child without also implicating the mother. In the first place, this faculty is shared by no other contagious disease. No father can give his offspring small-pox, though the mother frequently communicates that disease to her fœtus. In the next place, it is well known, as Colles of Dublin long ago pointed out, that a congenitally syphilitic child never infects its mother, though it will transmit its disease readily to a wet-nurse, whose breasts it sucks; this apparent exemption of the mother being due to the fact that she has been already infected with the disease. Again, the symptoms of syphilis are often exceedingly mild in women, and constantly overlooked. Hence, in the present state of our knowledge, it is safer to conclude that the father infects the mother, and that she again transmits her disease to the offspring.

Ricord, however, states that a mother, pregnant with a syphilitic fœtus, the offspring of a father laboring under constitutional disease, can be infected through it without herself having had primary syphilis; and Jonathan Hutchinson has lately advanced a considerable amount of evidence in support of this doctrine, which, nevertheless, fails to carry conviction to my mind that such communication ever takes place. Then, again, there is no doubt that a wet-nurse laboring under constitutional syphilis can infect the child that she suckles, the infant being contaminated through the medium of the milk. Ricord, and many others of equal authority, admit this. [Cullerier has by numerous observations at the Hôpital de Lourcine proved (as clearly as a negative proposition can be proved) that syphilis is *not* transmissible through the secretion of milk. When infants are infected by their nurses, it is owing to the existence of primary or secondary lesions upon the breast.—A.] My own opinion is that syphilis is, though rarely, so transmitted; and, indeed, there are a number of cases on record in proof of this (*vide Ranking's Abstract*, vol. iv). The converse is also a matter beyond dispute: a syphilitic child can infect a healthy nurse. This point is one of very great importance, inasmuch as actions for damages have been brought by women who have stated that they have become diseased from the child that they have nursed. There are cases recorded that prove it incontestably; and, on such a question as this, one positive fact must necessarily outweigh any amount of negative evidence. Not only have Hunter and Lawrence related cases in which an infected child communicated the disease to several nurses in succession; in Hunter's case three wet-nurses were successively infected, two of whom gave the disease again to their own children; but a considerable mass of evidence upon this point is to be found in *Ranking's Abstract* (*loc. cit.*). The disease is especially apt to be communicated in this way, if the nurse have any crack or abrasion upon her nipple, and the infant sores upon the mouth. Colles, however, who had great experience in syphilis, states that the disease may be communicated to the nurse from an infected child, by mere contact, without excoriation.

Symptoms.—The symptoms of infantile syphilis are sufficiently well marked: consisting principally of cachexy, with disease of the mucous and cutaneous surfaces. The first indication is usually the *atrophic and cachectic appearance* of the child; this not unfrequently shows itself at birth, and when it does so, such children are often small, shrivelled, wan, and wasted, when born; the face especially has an

aged look, the features being pinched, and the flesh soft and flabby; the complexion generally has a yellowish or earthy tinge; and these characters continue until the disease is eradicated from the system of the child. But it is more usual for the disease to delay its appearance until a month has elapsed after birth. Diday and De Méric have collected a large number of cases, in most of which the disease was developed in the fifth and sixth weeks. Many betrayed their disorder in the first month; in some few it was delayed until the child had attained the age of three months. The earlier the disease shows itself, the more fatal are its effects. Children who are not attacked till they are two or three months old, usually recover their health in a short time. Nor, when the child is born with syphilitic eruptions, is it always atrophic and ill-nourished, though such a condition is the ordinary one.

The first local sign that declares itself is usually a congested condition of the mucous membrane of the *nose*, giving rise to the secretion of offensive mucus, and causing the child to make a peculiar snuffling noise in breathing, as if it had a chronic catarrh; this snuffling may exist from the time of birth, but generally comes on very shortly afterwards. The mucous membrane of the mouth is also liable to attacks of inflammation, and this *syphilitic stomatitis* is a very marked characteristic of the disease.

The disease manifests itself upon the *cutaneous and mucous surfaces*, sometimes before or at birth, in other cases not until several weeks have elapsed. The most common period for the occurrence of these signs is the third or fourth week. The cutaneous eruption usually makes its appearance on the nates, the scrotum, the soles of the feet, and around the mouth; hence, in examining a syphilitic child, these parts should always be looked at first. It presents itself in three different forms: most frequently as flat tubercles, varying in size from a split pea to a four-penny-piece, smooth, slightly elevated, and of a coppery or reddish-brown color. These tubercles are often accompanied by cracks and fissures about the mouth and anus. Though commonly called *squamous*, they are not in reality scaly, but are always smooth and flat. Intermixed with these are brownish maculæ or spots, differing in size, and variously figured.

The vesicular or bullous eruption is not so common as those just described, yet I have frequently seen it in syphilitic children. It appears in the form of vesicles, about the size of a split pea, with a dusky coppery areola and base; drying into brown scales or scabs, and commonly conjoined with the tubercular affection. The bullæ are most frequently seen on the soles of the feet.

When we consider the influence exercised by the syphilitic poison upon the skin, and its appendages the hair and nails, we should *à priori* have expected that the *teeth*, as a portion of the dermal skeleton, would participate in the morbid action induced by it on the allied structures. The fact of their doing so does not, however, appear to have attracted the notice of any observer, until J. Hutchinson directed the attention of the profession to this very interesting subject, and pointed out the destructive and special influence exercised upon the teeth by secondary constitutional syphilis. This injurious influence manifests itself both in the temporary and in the permanent teeth; but only with its specific and peculiar characteristics on the permanent set. It must not, however, be supposed that in all cases of infantile syphilis the teeth are affected; indeed, in many instances they are not, and it has been particularly pointed out by J. Hutchinson that it is only when there have been attacks of syphilitic stomatitis, that we are to expect to meet with these changes in the teeth from their normal types.

Fig. 213.

Syphilitic temporary teeth.

The *temporary teeth* of syphilitic infants are cut early, are of bad color, and liable to a crumbling decay (Fig. 213). The upper central incisors usually suffer early, and always first; then the laterals become carious and drop out; and lastly, in some cases though rarely, the canines wear away so as to present a tusk-like appearance. In consequence of the early decay of the incisors, children are often edentulous, so far as these teeth are concerned, from an early age, until the permanent ones are cut.

The *permanent teeth* present the more marked characteristics of an inherited syphilitic taint; and in these, as in the temporary, the disease declares itself chiefly in the incisors of the upper jaw, and first in the central ones. These will be observed to be usually of a bad color, short, peggy, rounded at the angles, standing apart

with interspaces, or converging, and marked by a deep broad notch. They are soft and crumbling, are slender, and readily wear down (Fig. 214).

Fig. 214.

Syphilitic permanent teeth.

Treatment.—The occurrence of syphilis in the infant may be *prevented* by putting the infected mother on a mercurial course so soon as her pregnancy is ascertained; this indeed may be necessary in order to prevent miscarriage, but should be done cautiously, and by inunction, rather than by mercury administered by the mouth. Should repeated miscarriages have occurred, as the consequence of constitutional syphilis, one or other, or both the parents, if at fault, should be put upon a mercurial course; and thus the recurrence of this accident may be prevented.

The *curative treatment* as regards the child is extremely simple. It should be brought up by hand, lest it infect the nurse or continue to receive fresh accession of poison from the diseased milk of its mother. [Cullerier has shown that this precaution is unnecessary.—A.] It must then be put under the influence of mercury, which in these cases acts almost as a specific; and, indeed, the ready manner in which all disease may be eradicated from the system of a syphilitic child by this mineral, is perhaps one of the strongest proofs that can be adduced of the specific character of its action on the venereal poison. The mercury may be given by the mouth in the form of small doses of hydrargyrum cum cretâ; but, as it often purges the child when administered in this way, Brodie has recommended its introduction into the system by inunction, which process I invariably employ, and have found it a most successful mode of treating the disease. The most convenient plan is, as recommended by Sir Benjamin, to spread a drachm of mercurial ointment on the under part of a flannel roller stitched round the thigh just above the knee, and to renew this every day. The treatment should be continued for two or three weeks, until all rash and snuffling have disappeared, when, the mercury having been discontinued, the cure may be perfected by the administration of small doses of iodide of potassium in milk or cod-liver oil. Occasionally the cutaneous manifestations of infantile syphilis are complicated with, and obscured by, some of the common diseases of the skin incident to early childhood; more particularly with eczema impetiginodes of the head, face, and body. In these circumstances the diagnosis may not be easy, though the history of the case, the concomitant appearance of two forms of the disease, and the existence of snuffling and cachexy, tend to establish it. The eczema also, in these circumstances, is browner and more squamous than usual. In cases such as these, the best plan is to treat the syphilitic affection first with the mercurial inunction, and then to put the child under a mild course of Donovan's solution, two or three minims for a dose, keeping it at the same time on a good nourishing diet.

DISEASES OF TISSUES.

CHAPTER XXXVII.

SURGICAL DISEASES OF THE SKIN AND ITS APPENDAGES.

The various specific cutaneous affections, such as eczema, scabies, impetigo, acne, lepra, psoriasis, &c., probably fall within the province of the surgeon, and are commonly treated by him in practice; but, as the consideration of these diseases would necessarily lead into the whole subject of dermatology, the limits of this work would not allow me to discuss so extensive and special a branch of surgery; and I must therefore content myself with the consideration of some of those affections of the skin, which, as requiring manual assistance, may perhaps be more properly

looked upon as within the scope of the present treatise. These diseases may be considered under the several heads of diseases of the appendages of the skin, as of the cuticle and nails; the non-malignant ulcers of the skin; and the malignant ulcers and tumors of this tissue. We have already, in Chapter XXIX., considered the ordinary non-malignant ulcers of the skin, as well as some of the simple tumors that occur in connection with this tissue; we shall here, therefore, only consider the *diseases of the appendages of the skin*, and the *malignant ulcers and tumors*.

DISEASES OF THE APPENDAGES OF THE SKIN.

Warts consist of elongated papillæ, with strata of thickened and hardened cuticle, usually situated about the hands and face, and chiefly affecting young people; they appear in many cases to be simple overgrowths of the cutaneous structures, coming and going without any evident cause. In other cases they are of a more permanent character, becoming hardened and dark in color, and continuing perhaps through life.

The *treatment* of these affections is usually sufficiently simple. As their vitality is low, they may be readily destroyed by the application of caustics or astringents; among the most useful of these I have found the concentrated acetic acid and the tincture of the sesquichloride of iron. Brodie recommends the solution of a drachm of arsenious acid in half an ounce of nitric acid. In some cases they may be ligatured or snipped off with advantage.

Corns usually consist of small thickened masses of epidermis, accumulated on those points on which undue friction or pressure has been exercised, in order to guard the subjacent cutis from injury. These epidermic masses are usually hard, dry, and scaly; at other times they are soft and spongy, owing to their being situated in places where the secretions of the skin accumulate, thus keeping them moist. Under old and very thickened corns, it is stated by Brodie that a small bursa is occasionally found. Corns are at all times sufficiently painful, but become especially so if inflammation or suppuration takes place underneath them; the accumulation of a small drop of pus under the thickened cuticle, which prevents its escape, giving rise to very intense agony. There is a special form of corn that I have seen only in the sole of the foot, and which may become the source of the greatest possible pain and inconvenience to the patient, preventing his walking, and in fact completely crippling him. This corn is usually of small size and round in shape, the neighboring cuticle being always greatly thickened and hardened. It is extremely sensitive to the touch, the patient shrinking when it is pressed upon, as if an exposed nerve had been injured. On slicing it down with a scalpel, it will be found to be composed of soft, tough, and white epidermis, arranged in tufts or small columns, in the centre of each of which a minute black dot is perceptible. Each tuft appears to be an elongated and thickened papilla, and the black speck is a small point of coagulated blood which has been effused into it. Around the depression in which each of these corns is seated, the hardened cuticle forms a kind of wall.

The *treatment* of ordinary corns consists in shaving or rasping them down so as to prevent the deep layers of cuticle, retained by the indurated superficial ones, from giving rise to pain by pressure on the papillæ of the cutis. Relief may also be afforded by removing all pressure from bearing upon the corn, by attention to the shape of the shoe, and by wearing a piece of soft leather or of amadou, having a hole cut in the centre into which the corn projects. It is well to avoid the application of caustics to ordinary corns; injurious consequences being often produced by these agents, especially in elderly people, in whom fatal gangrenous inflammation, as I have seen in one case, may be excited by their action. If the corn suppurate, it must be poulticed and shaved down, and the drop of pus let out by puncture with a lancet. In the painful papillated corn of the sole of the foot, I have found the application of potassa fusa, so as to destroy it thoroughly, to be the best and the speediest remedy, and, as this corn always occurs in young people, no danger attends its use; or a poultice followed by the application of a blister may bring it away.

Diseases of the Nails.—The nails may become diseased, either by undergoing structural changes, by having their matrix inflamed, or by growing into the soft tissues of the toes.

In some broken states of health, and especially in persons suffering from squamous disease of the skin, the nails occasionally become blackish or dark-brown in color, are rugged, dry, and cracked, scaling off, as it were, without any apparent affection of the matrix. This condition, of which I have seen several instances, is best cured by a course of alteratives and sarsaparilla, the disease yielding as the general health becomes improved.

Onychia is a disease of the nails dependent on inflammation of the matrix; it occurs under two forms, the *simple* and the *specific*.

In *simple onychia* there are redness, heat, and swelling, usually on one side of the nail, in the angle of the tissue in which it is implanted; there is discharge of pus, and the nail gradually loosens, becomes dark colored, somewhat shrivelled, and may eventually be thrown off, a new nail making its appearance below, which commonly assumes a somewhat thickened and rugged shape. This disease usually results from slight degrees of violence, as the running of thorns and splinters into the fingers.

The *treatment* consists in subduing inflammation by local antiphlogistics, poulticing, &c., and watching the growth of the new nail, which may be sometimes usefully directed by the application of a layer of wax.

Specific onychia is a more serious affection, and is often dependent on injuries inflicted on the finger in a syphilitic or cachectic condition of the system. In it a dusky-red or livid inflammation takes place at the sides or root of the nail; ulceration is set up, accompanied by the discharge of sanious and very fetid pus; and large loose granulations spring up at its root and sides, so that the end of the toe or finger that is affected (and this is most commonly either the great toe, the thumb, or the index finger) becomes greatly enlarged and bulbous in shape. The nail then shrivels, becomes brown or black, and peels off in strips (Fig. 215); after its separation, thick epidermic masses, forming aborted attempts at the production of a new nail, are deposited at the base and sides. In the *treatment*, both local and constitutional means are required. The first and most essential point is to *remove the nail*, either in whole or part, as it acts as a foreign body, and prevents the healing of the surface from which it springs: the ulcer should then be well rubbed with the nitrate of silver, and dressed with black wash. Colles recommends fumigating it with a mercurial candle, made by melting a drachm of cinnabar and two ounces of white wax together. The *constitutional treatment* consists of means calculated to improve the general health; with this view Sir A. Cooper recommends calomel and opium. I have generally found bichloride of mercury, with sarsaparilla or bark, the most useful remedy.

Fig. 215.

Specific onychia.

Ingrowing of the Nail is an extremely painful and troublesome affection, principally occurring in the great toe, and brought about by wearing pointed shoes, by which the sides of the soft part of the toe are pressed upon, and made to overlap the edge of the nail. An ulcer here forms, the liability to which is greatly increased by the nail being cut square, so that the flesh presses against a sharp and projecting corner of it; this ulcer secretes a fetid sanious discharge, and large granulations are thrown up by it. The consequences of this condition are lameness and inability to walk or even stand with comfort.

Treatment.—Various plans have been devised with a view of raising the edge of the nail, partially removing it, and pressing aside the soft structures. I have never, however, seen much permanent benefit result from any of these means; and the only method that is, I think, really serviceable to the patient, is the removal of the whole nail. As this operation is an excessively painful one, the patient should be anæsthetized, or the matrix should be rendered insensible by congelation. The surgeon holds the diseased toe in his left hand, and then, running one blade of a strong sharp-pointed pair of scissors under the nail up to its very root, he cuts through its whole length, and, removing the scissors, seizes first one half and then the other with a pair of dissecting forceps, and twists them away from their attachments. The raw surface left is covered with water-dressing, and speedily throws out granulations which form the rudiments of a new nail. The new nail usually

Fig. 216.

Hypertrophy of toe-nail.

grows straight and healthily. In some rare cases, however, I have seen a faulty direction assumed by it.

Avulsion of the toe-nail is usually unattended by danger. I was, however, once called upon to amputate a foot for gangrene, which had followed the operation performed on an elderly person.

Hypertrophy of Toe-Nail.—Occasionally from neglect the toe-nail may become enormously hypertrophied and twisted, looking more like a horn than a nail, as in the accompanying drawing (Fig. 216), taken from a patient in whom the nail had been allowed to grow uncut for twenty years, producing complete lameness. I removed the nail whole by avulsion, and a sound and useful foot resulted.

MALIGNANT TUMORS AND ULCERS OF THE SKIN.

Cheloid and **Fibro-Vascular Tumors** of the skin are semi-malignant growths situated on the trunk and extremities, usually flat and expanded, oval, round, or irregular in shape, slightly elevated above the surface of the skin, and commonly occurring in otherwise healthy individuals. They may remain stationary for years, but not uncommonly have a tendency eventually to ulcerate, to bleed, and to assume a sort of malignant action; at other times they extend slowly, without ulceration, moving forwards as it were upon the skin, the part over which they have passed assuming much the appearance of the cicatrix of a burn, being red, contracted, drawn in towards the centre, and wrinkled. Closely allied to these are those fibroplastic growths that have a tendency to sprout up in scars, constituting the *warty tumors of cicatrices*, described by Cæsar Hawkins. This morbid condition appears to be simply an abnormal increase in the activity of the development of the cicatricial tissue, which springs up with great luxuriance. They are especially apt to follow the irregular cicatrization of burns, more particularly in children. I have, however, seen them in the adult, occasioned both in this way and by the irritation of a blister. The warty cicatricial tissue chiefly develops on the chest and neck, and is commonly attended by much itching and tingling, often of a most distressing character. It is very vascular, bleeding freely when incised.

Treatment.—These various forms of tumor should, if possible, be extirpated early by the knife, as they do not appear to be amenable to any constitutional or local treatment, and have certainly a disposition to malignant degeneration. As there is a great tendency to local recurrence of the disease after removal, it should be widely excised; but even then it is likely enough to return, requiring perhaps repeated operations before the patient can be freed from it.

Lupus.—Under the term *lupus*, various semi-malignant and malignant affections of the skin, of very different kinds, are commonly included; indeed, the distinctions between lupus and the different forms of epithelial cancer have not as yet been well made out. There are three forms, at least, in which the diseases included under the term lupus may make their appearance: 1, as a superficial affection of the skin, not attended by ulceration, but accompanied by important and destructive changes in its tissue; this is the lupus non-exedens of some writers; 2, as a slowly ulcerating form of the disease, giving rise to the different varieties of lupoid ulcer; and 3, as the lupus exedens, a disease of a rapidly destructive character, not only eroding superficially, but destroying the tissues deeply. These various forms of lupus are most commonly seated on the face or neck, or are occasionally met with on other parts of the body, as upon the limbs or trunk.

1. *Lupus non-exedens* appears in the shape of a red patch on the skin, covered by fine branny epidermic desquamation; it may remain stationary for years, or slowly spread over a great extent of surface, producing contraction of the skin, with wrinkling and drawing in of the features, and much stiffness in their movements. The integument affected by it may be in one of two states; it may either continue red, irritable, and branny, having the appearance of a thin cicatricial tissue, and in this way the greater part or the whole of the face may be affected; or it may leave a firm, white, smooth, and depressed cicatrix, exactly resembling that produced by a burn, along the anterior margin of which the disease slowly spreads, in the form of an elevated ridge composed of soft bluish-white or reddish tubercles.

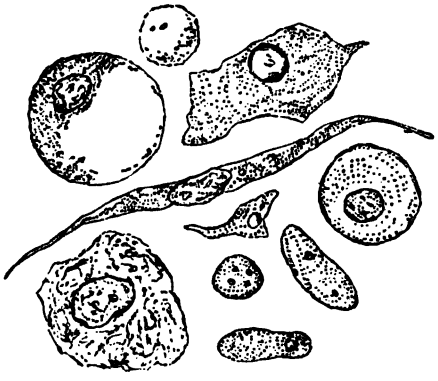
2. *Lupoid ulcer* usually occurs about the face or neck, but sometimes on the extremities of elderly people, or of those in broken health. It may commence as the last described variety, which after a time breaks into an ulcer; or a small crack forms in the first instance, which scabs over, and, as this scab separates, the characteristic sore appears. It is in the first case a round or oval flat ulcer, without granulations on its surface and without action in it, with somewhat elevated edges, often stationary, at other times slowly extending; in this way it may continue for months upon the cheeks or neck. In other instances it spreads more rapidly, attaining a large size, and presenting a somewhat fungating surface, from which some purulent discharge is thrown off. This form of sore I have most commonly seen about the ears and occiput in elderly persons. In other cases again it spreads with great rapidity, giving rise to extensive ravages; thus, I have seen it extend down the whole side of the neck, from the ear to the clavicle, cleanly dissecting away the skin, and exposing the structures immediately subjacent, as the acromial and clavicular branches of the cervical plexus of nerves, and destroying the patient by exhaustion.

3. *Lupus exedens*, or the more deeply ulcerating form of the disease, may begin in two ways, with or without the existence of a tubercle on the skin. It is most commonly seated on the nose, beginning by ulceration of the mucous or mucocutaneous surface, without any precursory tubercle, surrounded by redness of a violet or dusky hue, and attended by much inflammation, swelling, pain, and coryza. The ulcer is at first covered by a thick scab; as this separates, the sore extends, and often rapidly destroys one or both alæ, the tip and columna; after this the destructive action usually ceases for a time, the sore crusting over with grayish, hard, and adherent scabs; but, if not, it may go on eroding one half the face, producing a frightful rugged-looking cavity, and exposing and destroying the bones and large cavities of the face. I believe, however, that of these forms of disease, that which is limited to the nose, and that which extends widely over and through the face, essentially differ from one another. The first is generally of a *scrofulous* character, in fact consisting of strumous ulceration in one of the extreme parts of the body, the vitality of which is below its normal standard, and usually occurring in young persons, especially in women from eighteen to twenty-five years of age. Another form of this destructive ulceration is an extensive, deeply eroding, and fatal disease, affecting the whole of the soft tissues and bones of the face; it is distinctly of a *cancerous* character, and ought not, consequently, to be described as one of the varieties of lupus. A third variety is of *syphilitic* origin, being one of the most serious forms of tertiary syphilis.

The *strumous* form of lupus exedens, that which destroys merely the extremity of the nose, is commonly rapid in its progress, the part appearing to melt down under the disease, so that in the course of a few weeks the whole of the organ is destroyed. In other cases it is very slow, occupying perhaps many years, and partaking somewhat of the red and branny form of lupus non-exedens. Occasionally it is evidently associated with and dependent upon the syphilitic taint, and ought then to be considered rather as a variety of local syphilis in a strumous constitution than as a distinct affection.

Microscopic Structure.—It is not often that we have an opportunity of examining microscopically the structure of lupus. Some time ago, however, I removed by excision a patch of lupus non-exedens, which had existed for fourteen years under the chin of a woman aged thirty, who was otherwise in good health. On examination, it was found to be composed of large cells many times larger than blood-disks, having clear and very distinct cell-walls, and well-marked refracting nuclei. There were some cells clear and globular, without nuclei; others were fusiform and elongated, with nuclei, evidently undergoing fibro-plastic transformation (Fig.

Fig. 217.



Cells from lupus of the neck. Magnified about 1200 diameters.

217). Molecular movement was very distinct in one of these globular cells. The mass of skin appeared to be converted into granular matter, intermixed with these cells.

The *diagnosis* of lupus is not always easy, the disease being especially apt to be confounded with some forms of impetigo, with syphilitic tubercles and sores, and with cancer. From *impetigo* it may be distinguished by the absence of pustules, and of the thick gummy crusts characteristic of this affection, as well as by the less extent of surface implicated, and the deeper and more eroding form of the lupoid ulceration. From *syphilitic disease of the skin*, the diagnosis is not always practicable, inasmuch as true lupus may occur as the result of constitutional syphilis. In other cases, the history of the affection, the limitation of the disease, and the absence of intervening secondary manifestations, make it easy to distinguish one from the other. From *epithelial cancer*, lupus cannot in some cases be distinguished; the two affections indeed being closely blended together, and being scarcely recognizable as distinct diseases.

The *treatment* of lupus depends in a great measure upon the variety of the disease with which we have to do, and the constitutional condition attending it, and calls for the employment not only of local but of general remedies.

In *lupus non-exedens* we may, if the disease be limited, excise the patch and heal the sore that results by granulation. Not unfrequently, however, the cicatrix is apt to undergo fibro-vascular degeneration. If recourse be not had to excision, on account of the extent and superficial character of the disease, it is useless to attempt to destroy it by caustics. In every case in which I have seen these means tried, they have failed in effecting a cure. In some instances, however, the application of a strong solution of the nitrate of silver to the morbid surface will induce a healthier action; though in the majority of instances local applications of a soothing kind can alone be borne. Lotions containing glycerine are especially useful, as they prevent the surface from becoming dry and harsh. If the disease be situated on the face, care should be taken to avoid exposure to cold winds, dust, &c. In the *constitutional treatment*, the avoidance of stimulants of all kinds, the use of a bland diet, and the employment of some of the preparations of arsenic, will be found to be the most likely means to effect a cure. Indeed, arsenic may be considered the great remedy in this disease; the liquor arsenicalis, or the iodide in combination with small doses of biniodide of mercury, will be found extremely useful; Donovan's solution is also most beneficial in many instances.

In the treatment of the *lupoid ulcer*, the same constitutional remedies should be employed as have just been described, and a healthy action induced in the sore by the application of the chloride of zinc paste to the whole of its surface. The best mode of applying this is to keep the chloride prepared for use by being mixed with two or three parts of flour. When wanted, a sufficient quantity of this powder should be made into a stiff paste, by the addition of a little water, and then spread over the surface to be attacked by it, in a layer of about the thickness of a wafer; this should be left on for two or three hours, and then removed, the sore being covered with a piece of water-dressing until the grayish slough that has been produced has separated, when the caustic may be reapplied as often as necessary. Besides the chloride of zinc, various other caustics may be had recourse to, each of which possesses some peculiar advantages. The nitric acid is useful, if the action to be produced be not required to be very deep; for, as it hardens and coagulates the tissues to which it is applied, it does not consequently extend so far as the chloride. The acid nitrate of mercury presents the same advantage as the nitric acid and other fluid caustics—that it can be applied into the fissures and hollows of the part into which the more solid caustics do not penetrate, and is certainly useful in inducing a healthy action in the part, especially if there be a syphilitic taint. The potassa fusa and Vienna paste are useful, so far as their destructive properties are concerned, but are somewhat uncontrollable, and apt to spread. The most convenient mode of applying them is to cut in a piece of plaster a hole of the exact size and shape of the ulcer, to apply this around its borders, then to cover the sore with a layer of potassa cum calce, one line in thickness, and over this to lay on another piece of plaster. In this way a considerable amount of caustic action may be induced, which will be limited to the exact surface to which it has been applied. Of all these caustic applications, however, I give the preference to the

chloride of zinc; its action is more continuous, and appears to give a healthier stimulus to the part than any of the other agents.

The treatment of *lupus exedens* must have reference to the *constitutional* condition in which it occurs; if this be of a strumous character, the administration of cod-liver oil and the iodide of potassium, with a nourishing diet, will be most serviceable; in a syphilitic constitution, the remedies that are applicable to the cure of tertiary syphilis, such as the bichloride of mercury and Donovan's solution, are especially useful. In many cases also in which there can be no suspicion of a syphilitic taint, these preparations of mercury, as well as the iodides of the same metal, may be administered empirically with great advantage. The liquor arsenicalis, or the combination of arsenic, iodine, and mercury that exists in Donovan's solution, or that is contained in a pill composed of one-sixth of a grain of iodide of arsenic and one-twelfth of a grain of biniodide of mercury, as recommended by A. T. Thomson, has appeared to me to be extremely beneficial, and in many cases certainly exercises a marked influence in arresting the disease. Whilst the patient is undergoing a course of these remedies, much attention requires to be paid to diet, clothing, and his general hygienic conditions.

In the *local treatment*, the first thing that requires to be done is to subdue inflammatory action and irritation, by leeches, emollient lotions, and opiate or hen-bane poultices. As this subsides, the progress of the disease will usually be arrested, for a time at least; and then, by the application of the nitric acid, chloride of zinc, or the acid nitrate of mercury, to the surface, a more healthy action may be set up, and the sore be made to cicatrize. Great mischief, however, may result if the caustics be applied too early, or if irritating ointments be used, as the destructive nature of the disease will then be augmented. The inflammatory redness and branny desquamation, resembling lupus non-exedens, that surround the ulcer, may usually most readily be made to disappear by the repeated applications of a strong solution of the nitrate of silver, which should be applied every second day by means of a camel-hair brush. The cicatrix that forms in this disease is thin, and breaks readily, giving away on exposure to cold, or on the occurrence of constitutional derangement. The patient should, therefore, for some length of time after recovery, be careful not to expose himself to any such influences. In the more rapidly spreading and worst forms of *lupus exedens*, that horrible disease termed by the older surgeons "Noli-me-tangere," nothing can be done beyond the relief that is afforded by the administration of opiates, and a general sedative plan of treatment.

Cancer of the Skin.—Cancer may occur in the skin as a true scirrhous or encephaloid deposit; most commonly, however, those affections of the skin termed cancerous consist of the epithelial form of the disease, and are usually seated about the lips, face, and scrotum, or at the orifices of the mucous canals; these we have already considered generally, and shall have to revert to them more fully when treating of the special affections of these parts. Some forms of lupus, also, may be of a cancroid character, but they do not exhibit the true evidence of malignancy by infecting the system, and giving rise to secondary deposits in the different viscera.

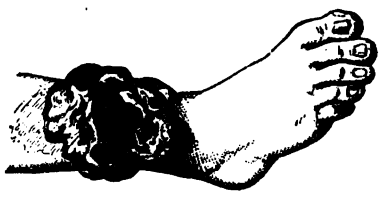
True cancer of the skin may occur in three forms: 1, as the indurated wart of a scirrhous character, specially described by Scarpa; 2, as scirrhous or encephaloid infiltration and fungus; or 3, as ulcers which, primarily originating from some local irritation of a simple kind, may, by the persistence of this, assume a truly cancerous character; thus I have seen the scrotum and the neighborhood of the apertures of fistulæ in perinæo, in a case of old-standing disease, become converted into a truly cancerous mass.

1. The *scirrhous wart* is usually of the natural color of the skin, but sometimes of a reddish or dark-grayish hue, hard, and somewhat irregular in shape. It may remain for a long time stationary, but at last ulcerates and spreads rapidly, giving rise to vast destruction of parts; the ulcers formed by it presenting the characters of cancer, with a hard base, everted edges, and foul surface.

2. The *infiltrated cancer* of the skin occurs in the form of a flat dark induration, which scabs over with dark, rugged, grayish-brown incrustations, having shooting pains in and around it, and after remaining stationary perhaps for years, runs into ulceration, and rapidly destroys the parts it affects; after ulceration has been set up, the patient's life, according to Walshe, is seldom prolonged beyond two years. *Encephaloid cancer* of the skin is of rare occurrence, but occasionally forms large fungating masses sprouting from, and solely connected with, this tissue.

3. *Cancerous ulcers* of the skin may arise from the irritation and contact of secretions, as of the urine; or an unhealthy and specific action may be set up in an old ulcer, as of the leg, and cause it to assume a cancerous character (Fig. 218). These cancerous ulcers may indeed occur upon almost any part of the body; I have seen them on the back, breast, fingers, hand, thigh, and sole of the foot. They are flat, gray, or sloughy-looking, often with warty granulations, a good deal of induration about them, and but little discharge.

Fig. 218.



Cancerous ulcer of the leg.

The *treatment* of cutaneous cancer consists in its excision, or in amputation of the part affected. Its removal by excision, whether in the form of wart, crust, or ulcer, should be effected as soon as its true characters have declared themselves; provided it be of such a size, and so situated that it can be freely removed with a sufficient stratum of subjacent healthy parts, and a wide border of surrounding skin. Should it be so situated that its excision through surrounding healthy tissue is not practicable, recourse must be had to amputation of the limb, as was done in the case depicted in Fig. 218. In such circumstances, the limb may be removed at no great distance above the disease; it not being necessary, as in other cases of cancer of the extremities where the bones are affected, to allow a joint to intervene between the seat of operation and the malignant growth.

CHAPTER XXXVIII.

DISEASES OF THE NERVOUS SYSTEM.

NEURITIS.

INFLAMMATION *of the nerves*, or rather of the neurilemma, is not of very unfrequent occurrence, being usually the result of rheumatism, of wounds or of strains. When neuritis is rheumatic, it principally affects the nerves of the face and the lower extremity.

Symptoms.—These consist of tenderness on pressure along the course of the nerve, and severe continuous pains running down its trunk and ramifying along its branches, with occasional violent exacerbations, especially on moving or touching the part, and at night; there is usually swelling along the course of the trunk, and some constitutional pyrexia. When chronic, this condition may readily be confounded with neuralgia; of which, indeed, it constitutes one variety. On examination after death, in these cases, the sheath of the nerve will be found injected and swollen, and the nervous tissue softened.

Treatment.—This consists in the employment of antiphlogistic means; cupping or the application of leeches, according to situation, poppy or belladonna fomentations, and local emollients. When the neuritis is rheumatic, the acetous extract of colchicum is the best remedy; when it is of a more chronic and nocturnal character, iodide of potassium, either alone or in combination with sarsaparilla, may advantageously be given.

NEURALGIA.

Neuralgia frequently occurs in surgical practice, either complicating other diseases, or as a distinct affection simulating closely various organic lesions, more especially of joints and bones.

Symptoms.—The pain in neuralgia is the essential symptom, and in fact constitutes the disease itself. It may be of two kinds; either following anatomically the course of a nerve and the distribution of its filaments; or affecting a considerable portion of the surface without reference to any special nerve. It is of all de-

grees of severity, sometimes moderate, sometimes unendurable, even by those who possess the greatest fortitude; when severe, it usually comes on suddenly, with a kind of shock, and continues of a sharp darting or tearing character, coursing along the trunk or ramifications of the affected nerve, the distribution of which may often be distinctly indicated by the direction the pain takes. It is often accompanied by other sensations, such as a tickling, smarting, or creeping feeling on the affected surface; in some instances relieved by pressure, in others increased by the slightest touch or movement of the part. Occasionally there is spasm in the muscles supplied by the affected nerve; in other cases, there are heat and redness of the surface, with increased secretion from the neighboring organs, as a flow of saliva or tears when the nerves of the jaw or eye are implicated. The duration of an attack may vary from a few moments to many days or months. The pain is most commonly intermittent or remittent; often irregularly so, but in some instances the periodicity is well marked.

Situations.—This disease may affect almost any part of the body; it is most commonly seated distinctly in the trunk and branches of a nerve. The divisions of the fifth pair are the most frequent seat of neuralgia; the pain may extend to the whole of the branches of this nerve on one side of the head and face, but more commonly it is confined to one of its principal divisions, such as the infra-orbital, which is especially liable to be affected; in many instances it is seated in the temporal and dental nerves. Not unfrequently some of the terminal twigs alone of one of these nerves become the seat of intense pain; thus occasionally the affection is found limited to a patch on the cheek, brow, or temple, from which it scarcely ever shifts. The posterior branches of the dorsal spinal nerves, and the intercostals, are also very commonly affected, though not to the same extent as the fifth pair. In other cases the whole of an organ, or part, becomes the seat of neuralgia, though no one nerve may appear to be distinctly implicated; thus the testes, the breast, the uterine organs, or one of the larger joints, as the hip or knee, are occasionally the seats of severe suffering of this kind. An extreme degree of cutaneous sensibility is a marked feature in the affection in some cases; the patient wincing and suffering severely whenever the skin is pinched or touched, however lightly.

Causes.—The causes of this very painful disease are very various; they may be constitutional or local. It seldom occurs in strong and healthy individuals, but is almost invariably associated with want of power, unless it be occasioned by some local mechanical cause. *Depressing influences* of all kinds are especially apt to produce it; thus, debilitating diseases, mental depression, and particularly exposure to malaria, are common occasioning causes; those forms of the disease that arise from malarial influences, or from exposure to simple cold and wet, usually assume a very intermitting or periodical character, and are commonly seated in the nerves of the head. The *hysterical temperament* very frequently disposes to the spinal and articular forms of neuralgia. There is no constitutional condition with which neuralgia is more frequently associated than with anæmia: hence its frequency in females. As Romberg somewhat poetically says, "Neuralgia is the prayer of the nerve for healthy blood." Various sources of *peripheral irritation*, as loaded bowels, the irritation of worms, carious teeth, uterine disease, and calculus, may be recognized as producing some of the more obscure varieties of the disease.

Neuralgia may also arise from any compression exercised upon the trunk of a nerve; and in this way, indeed, some of the more intractable forms of the affection have their origin. Thus, thickening of the neurilemma, the pressure of a tumor of any kind, or of a piece of dead bone, may give rise to the most intense pain in the part supplied by the irritated nerve; and it is not improbable that, in many of the cases of neuralgia in the branches of the fifth nerve, pain may be owing to periosteal inflammation, or to some other disease of the osseous canals through which the divisions of the nerve pass.

Diagnosis.—The diagnosis of neuralgia, though usually effected without any difficulty, is in some cases a little embarrassing, as the pain may occasionally simulate that of organic disease or inflammation of the part. From *organic disease* of the part that is the seat of suffering, such as the hip, the knee, the testis, or the breast, this disease may usually be distinguished by the coexistence of cutaneous sensibility, the existence of the hysterical temperament, and the absence of the other signs that would accompany lesion of structure in the part affected. From *inflammation* the diagnosis is usually sufficiently easy, by attending to the inter-

mittent character of the neuralgic pain, to its occurrence in hysterical temperaments, and to the absence of the constitutional symptoms of inflammation. But occasionally, when local inflammatory irritation is conjoined with the neuralgia, the diagnosis is truly difficult. Here the presence of cutaneous sensibility and the relief of the pain by firm pressure will indicate neuralgia; whereas, in inflammation, there is no tenderness of surface, but the suffering is aggravated by deep pressure.

Treatment.—The treatment of neuralgia must have reference to the cause of the disease, and will be successful or not according as this may be more or less readily removed. So long as the conditions that primarily occasion the disease subsist, the pain is likely to continue: and if these conditions be irremovable, the disease may be looked upon as necessarily incurable, though the suffering may be alleviated by appropriate means. When it arises from any central nervous affection, there may be fear of the ultimate occurrence of disease of a more serious type, such as epilepsy, insanity, &c.

When it occurs as the consequence of anæmia, or in the hysterical temperament, the administration of the more stimulating and stronger preparations of iron, such as the sulphate or the sesquichloride, or the mistura ferri composita, either alone or in combination with quinine, with attention to the state of the bowels and of the uterine functions, and a general tonic regimen calculated to brace and improve the general health, such as sea-bathing, the cold douche, or sponging, will be found to be of essential service. In some of these cases the combinations of zinc, especially the valerianate, with the fetid gums, will remove the disease when iron does not influence it much. At the same time, the application or inunction of belladonna or aconite plasters and liniments may be of service. When the neuralgia is distinctly periodical, quinine in full doses, or the liquor arsenicalis, will usually effect a speedy cure. When it is rheumatic, occurring in debilitated subjects, and attended by distinct nocturnal exacerbations of pain, no remedy exercises so great an impression upon it as the iodide of potassium, especially when administered in combination with quinine.

In the more severe and protracted forms of the disease, relief may be occasionally obtained by attention to the state of the liver and digestive organs, by a course of the more purgative mineral waters, and by the occasional administration of aloetics or croton oil, followed by tonic remedies.

Local applications of a sedative kind, such as chloroform, belladonna, aconite, opium, &c., are often useful adjuncts to constitutional treatment. Perhaps the readiest mode of affording relief locally is that introduced by Alexander Wood of Edinburgh. This consists in injecting a few drops of a strong solution of morphia into the skin of the part affected, by means of the syringe figured at p. 572. Not more than half a grain of morphia should be injected at a time, and the action of this small dose is often very powerful. More than this, I believe, would be unsafe; but the injection may be repeated, if necessary, at intervals of a few hours. In some cases a single injection has cured neuralgia which has resisted all other means.

In many cases all these means, however, are unfortunately unavailing, and the sufferer is doomed to an existence of almost constant pain, except at times when the disease appears to cease of itself, or has its intensity blunted by the administration of the more powerful sedatives, such as morphia hypodermically, or veratria, aconite, or atropine externally. In these distressing cases the sufferer is ready to grasp at any means of relief that is held out to him; and section of the affected nerve is not unfrequently recommended as a last chance of the removal of disease. It is clear, however, that such an operation, though occasionally productive of temporary relief, cannot in most cases be expected to benefit the patient permanently; for by it the cause of the neuralgia is not removed, and it can consequently only be of service when the pain is peripheral, occasioned by some local irritation existing between the part cut and the terminal branches of the nerve. If the neuralgia depend on any central cause, or on local irritation existing higher up than the point divided, the operation must eventually be useless. Thus, if the source of irritation exist in the terminal branches of the infra-orbital nerve, the division of this trunk might be useful; but if the pain be occasioned by any pressure to which this nerve may be subjected in its passage through its canal by a carious state of the bones, or by disease of the periosteum, it would be unavailing; though it is a remarkable fact, that it not unfrequently happens that there is after these operations a tem-

porary cessation in the pain for a few weeks or months. In some of these cases, however, the pain shifts its seat from the branch operated on to another division of the same trunk; thus, if the infra-orbital have been divided, the inferior dental or submental nerve becomes the seat of pain. Or this may ascend, as it were, to the point at which the nerve was divided; thus, after amputation for neuralgia of the knee, the pain may return in the stump, and again when this is removed a second or even third time.

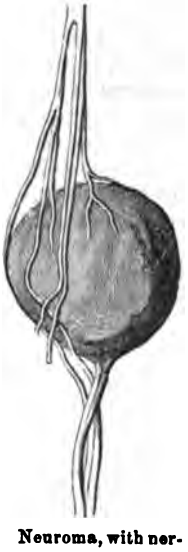
The nerves on which section has been most frequently performed are the different branches of the fifth—the infra-orbital, the inferior dental, and the submental. Should it ever be thought necessary to do it, it would be proper not only to divide the nerve, but to excise a portion of it; otherwise reunion will speedily take place, and, the continuity of the nerve being re-established, the operation will fail. The procedure, when applied to the infra-orbital and the submental, simply consists in cutting down on the trunk where it escapes from the foramen, isolating and dissecting out a portion of it; in doing this, no great difficulty can be experienced by any one possessing moderate anatomical knowledge.

The inferior dental nerve has in some cases of intense and persistent neuralgia been divided by a very ingenious operation. This consists in dissecting up a flap over the ramus of the lower jaw, applying a trephine to the bone so exposed, and cutting out a portion of it over that part where the nerve enters the dental canal, which is thus laid bare; when a portion of the nerve may be excised, by being raised on a director and snipped away with scissors.

NEUROMA.

By *neuroma* is meant a tumor connected with a nerve. This tumor may vary from the size of a millet-seed to that of a melon; it is usually solid, and composed of fibrous tissue; but when it attains a large bulk, a cavity may form in it, containing a yellowish or brownish serous-looking fluid, apparently owing to the disintegration of the central portions of the mass. In shape it is usually oval or oblong, the long axis corresponding to the course of the nerve (Fig. 219); it grows slowly, and is movable transversely, but not in the direction of the nervous trunk on which it is seated; it has no appearance of malignancy, and, however large it becomes, it never contracts adhesions to the integument nor involves its structure. Neuroma commonly only affects the nerves of the cerebro-spinal system; but Bérard has met with one case of the disease on a ganglionic nerve. The nerves of special sense are but very rarely the seat of this disease. Indeed, the only recorded case with which I am acquainted of a neuroma connected with one of these nerves, is one described by Lidell of New York, of a neuroma of the optic nerve filling up the orbit, flattening and protruding the eye, and extirpated together with the contents of the orbit by that surgeon.

Fig. 219.



Neuroma, with nervous filaments spread out over tumor.

Most commonly the tumor is single, and then is usually attended with very severe lancinating or neuralgic pain, which extends, however, only to the parts below the tumor, and is commonly paroxysmal. This pain is evidently owing to the stretching of the nervous twigs as they pass along the convexity of the growth. When single and painful, the tumor commonly goes by the name of the *painful subcutaneous tubercle*, and is then usually met with from the size of a pin's head to that of a cherry-stone, commonly seated upon the limbs, and most frequently in connection with one of the nerves of the lower extremity: but it may be situated upon the arm, the trunk, or even on the scrotum and cheek, where, however, it is not so commonly met with. Wherever neuroma occurs, it is acutely and intolerably painful on being touched, and is usually tender as well.

Structure.—The painful subcutaneous tubercle is composed of a white or grayish fibrous mass developed in the neurilemma, and having nervous filaments stretched through or over it. The nervous trunk above and below the tumor is normal; it is only where it comes into contact with the neuroma, and is exposed to its pressure, that it undergoes the change indicated. It is a very remarkable fact that, though

neuromatous tumors when single, or when but two or three exist, are most acutely painful, yet, when they are generally diffused over the body, they lose their sensibility, and are unattended by any inconvenience except such as arises from their numbers and bulk. The number of masses thus formed is often amazingly great; thus, in one of R. W. Smith's cases, described in a monograph which contains the fullest and most accurate account of this disease, he counted in the two lower extremities alone more than 250 of these tumors, besides those in other parts of the body. In another case related by him, there were upwards of 200 small neuromata scattered over the sides of the chest and abdomen, 450 on the right lower extremity, and upwards of 300 on the left; altogether probably not less than 2000 of these growths in "this unprecedented case."

Traumatic neuromata may arise from the wound or partial division of nerves, and occasion the most intense agony. Sometimes growths of this description of a fusiform shape, and varying from a cherry-stone to a pigeon's egg in size, are met with in stumps after amputations; in many instances they are unattended by inconvenience, but occasionally give rise to a very severe degree of pain.

Treatment.—The treatment of painful neuromata, whether of an idiopathic or traumatic character, or existing in stumps, consists in their excision. After removal, the part supplied by the nerve, which is usually necessarily divided, becomes paralyzed for a time, but may eventually regain its sensibility. In some cases, however, by cautious dissection, the tumor may be removed from the nerve that is in contact with it, without cutting this across. This has been done in the case of neuromata of the sciatic nerve and its divisions. When these tumors are numerous, they should not be interfered with; and, if unattended by pain, they need not be excised unless their bulk prove inconvenient.

TETANUS.

Tetanus is a disease consisting essentially in an excited state of the spinal cord and the medulla oblongata, in fact of the whole true spinal system, giving rise to painful and continued spasms of the voluntary muscles and the diaphragm, alternating with incomplete relaxation, and usually terminating fatally. This, which is one of the most serious and distressing diseases to which the nervous system is liable, is in the great majority of instances of a *traumatic* nature, being the consequence of some wound that implicates or irritates a portion of the peripheral nervous system; the local irritation so produced being propagated to and exciting the nervous centres, the excitation of which becomes persistent, and continues after the local cause has been removed, inducing reflex muscular movements in various parts of the body. The irritation of the nervous system, however, that induces tetanus, may arise from other sources besides surgical wounds, occasioning the *idiopathic* form of the disease; thus, for instance, the presence of worms in the intestinal canal, exposure to cold and wet, the ligature of the umbilical cord in infants, and even the uterine irritation following abortion, have been known to occasion it. These causes, however, rarely give rise to it in this country, and we must consequently regard it as a disease chiefly arising from traumatic lesion of some kind.

Causes of Tetanus.—Tetanus may occur at all *ages*, from the earliest infancy to an advanced period of life. In hot climates it is common amongst newly-born infants, in the form of *trismus neonatorum*. In this country it rarely occurs at this very early period of life, but is common in young adults. I have most frequently observed it between the ages of 16 and 25, and after that in old people; but it may occur at any period of life. It is far more common amongst *males* than females—in the proportion of about four to one. *Season of the year* seems to exercise little influence over it. It occurs in all states of the atmosphere, and at all periods of the year; but is certainly most common when the weather is suddenly changeable—alternating from heat to cold.

Tetanus may be occasioned by injuries that do not give rise to breach of surface; thus I have known it occur in a child who was suddenly thrown down upon its back by another at play; and Reid mentions a case produced by the stroke of a whip. But in the great majority of cases, it is directly occasioned by a *wound* of some kind. Generally a nervous twig has been lacerated, divided, or inflamed; and this seems to have been the starting-point of that disturbance of the spinal system of nerves which leads to the tetanic spasms.

The *kind of wound*, as well as its situation, doubtless influences materially the occurrence of the disease. Though it certainly more frequently follows punctured, torn, and lacerated, than clean-cut wounds, yet it occasionally complicates these, even when the result of surgical operations; thus, it has been known to follow the removal of the breast, amputations, the ligature of the larger arteries, and the operation for hernia. The minor surgical operations also are not free from the possibility of this dangerous complication. It has been observed after the operation for fistula in ano, the ligature of piles and varicocele, the removal of nasal polypi; and I have even seen a fatal case resulting from the introduction of an issue. Burns are a class of injuries that are peculiarly liable to be followed by tetanus. It is the common belief, both in the profession and out of it, that wounds of the hands and feet, and more especially of the ball of the thumb and of the great toe, are more likely to be followed by tetanus than those in other situations. I think the truth of this opinion may be doubted; though it is not improbable that tetanus may occur more frequently after injuries of these regions than of other parts of the body, simply because punctured and lacerated wounds are more common here than elsewhere. It cannot well be supposed to be owing to the tendons and fasciæ that abound here, as Hunter imagined; for it is seldom, if ever, met with after operations for tenotomy, which are so commonly practised on the feet.

Tetanus may occur in all *constitutions*—in the strong and robust, and in the feeble and emaciated. It is especially apt, however, to occur in feeble and debilitated individuals, and, indeed, may be looked upon as a disease of debility; hence any condition that lowers the tone of the nervous system is especially likely to occasion it. [Thus, in a fatal case at the Episcopal Hospital, the first symptoms appeared after a secondary hemorrhage.—A.] When it occurs in persons who are otherwise strong and in the prime of life, it will be found that they have been exposed to causes of depression influencing the nervous system. It is loss of nervous tone, and not muscular weakness, that disposes to this disease. Thus, in tropical climates, as in some of the West India Islands, and amongst the marshes of Cayenne, it occurs with peculiar frequency, the most trifling scratches or punctures being followed by the disease. Poland, who has exhausted the statistics of tetanus, states that the mortality from it is in London ·025, whereas in Bombay it is 2·5 per cent. of the total deaths. It is interesting to observe, that the natives of hot climates are far more liable to this disease than Europeans resident there.

In *military practice* tetanus is of common occurrence. Its frequency varies much in different campaigns and under different circumstances, season and climate. In the Peninsular war, it was estimated to occur in the proportion of about one case in every 200 wounded; in the Schleswig-Holstein war of 1849, according to Stromeyer, once in about 350 cases. In the Crimea it appears to have been of rare occurrence. Alcock's estimate of one to every 79 wounded is evidently too high. After naval engagements, however, the mortality has often been high, more particularly if they have taken place in tropical climates. Sir G. Blane states that, after Rodney's action in the West Indies, out of 810 wounded 20 were attacked with tetanus, being one in 40. All European army surgeons are agreed, that sudden changes from heat to cold are amongst the most frequent causes of tetanus amongst the wounded. Thus Larrey states that, after the battle of Moskowa, although the number of wounded was immense, there were few cases of tetanus, the heat being very great and continuous; whilst after Bautzen, where the wounded were left on the field all night exposed to severe cold, more than 100 had tetanus; and after the battle of Dresden, when great heat was followed by much wet and cold, the wounded suffered most severely. So, after some of the Indian battles, as Chillianwallah and Ferozepore, where the wounded lay exposed to cold nights after very hot days (Macleod), tetanus was of very frequent occurrence. Hennen states that a draught of air, whether hot or cold, directly blowing on the patient, is the most fertile cause of tetanus. The case appears to have been different in America, and tetanus does not seem to have arisen from exposure of the wounded to cold and night-air. Dr. Chisolm states that although, from the wooded nature of the country in which the battles were often fought, wounded men were not unfrequently left for two or three days on the ground, tetanus did not appear to be more frequent amongst them than in those immediately cared for.

The frequency with which tetanus occurs varies much. It often happens that not one case occurs in a hospital for some years, and then several are met with in close succession or simultaneously.

Period of Occurrence.—Tetanus may take place at any period after the infliction of the wound that occasions it. In hot climates especially, it may occur very speedily; thus, Robinson relates the case of a negro servant in the West Indies, who scratched his finger with a broken plate, and died of tetanus in a quarter of an hour. It is very seldom, however, in temperate climates, that it supervenes before the fourth or fifth day, usually from that to the tenth day. Larrey, who had great experience of this disease during Napoleon's campaigns in Egypt, met with it most frequently between the fifth and fifteenth days after the infliction of the wound. According to the experience of the surgeons of the Peninsular War, under whose observation many hundred cases came, the disease does not show itself after the twenty-second day; but though this may be the general rule, Sir G. Blane has related a case in which it took place as late as a month after the infliction of the wound. It is stated that it may occur after the cicatrization of a wound is completed; when this happens, the disease must rather be looked upon as being of an idiopathic character, accidentally occurring in a person who has been recently injured.

Forms.—Tetanus may be *acute* or *chronic*; being in some instances fatal in the course of a few hours, but usually lasting for three or four days. Poland states that at Guy's 51 per cent. of the cases were fatal before the fifth day after invasion. If the patient survive this time, the disease will commonly run on to the eighth or tenth day, and occasionally even for a longer period than this; thus, S. Cooper mentions a case in which it continued in a soldier for five weeks after amputation. The more chronic it becomes, the better is the chance of recovery; indeed, if the patient survive the tenth day, the prospect of a favorable issue to the case is materially increased. As a general rule, those cases are the most fatal which are most active in their symptoms; the danger being in the ratio of the acuteness of the attack, both as to severity and also as to rapidity of invasion after injury.

Symptoms.—The invasion of the disease is sometimes preceded by a general uneasiness on the part of the patient, a sensation of fear, or a sense of impending mischief. Abernethy was of opinion that tetanus was usually ushered in by a disturbed state of the digestive organs, the stools being offensive, and indicative of much gastric irritation. When the disease sets in gradually, it may be somewhat difficult of recognition in its early stages; if it come on suddenly, its nature is immediately evident. It is a remarkable fact that the cramps do not begin in the part injured; but, wherever this may be situated, they are always first noticed in the muscles supplied by the portio dura of the seventh nerve; and throughout, these and the muscles of the respiration are principally affected. [This rule is not without exception; in the only well-marked case of tetanus which I have ever seen recover, the cramps and spasms were especially developed in the injured limb.—A.] The first symptoms usually consist in the patient being unable to open his mouth widely, to take food or drink, the muscles about the temples, jaw, and neck, feeling stiff and rigid; this condition has given to the disease the popular term of *lockjaw*. As the affection advances, the countenance assumes a peculiar expression of pain and anguish, the features are fixed or convulsed from time to time, and the angles of the mouth drawn up, constituting the appearance called the *risus sardonicus*. When fairly set in, the disease is marked by spasms of the voluntary muscles of the most violent character, with much pain and partial remissions. The pain is of that kind that attends ordinary cramp in the muscles, as of the legs, and is usually very severe. The spasms are often of a jerking character, the patient being suddenly thrown up, or twisted on one side; the breath is drawn with a loud sobbing catch from spasm of the diaphragm, and from the same cause there is usually violent pain experienced in the epigastric region, darting across the spine. The muscles of the trunk are usually affected next in order of frequency to those of the head and neck, the body being bent backwards so as to form a complete arch (*opisthotonos*); more rarely it is drawn forwards (*emprosthotonos*); and still less frequently to one side. In some cases the body becomes perfectly rigid, like a piece of wood, the belly being drawn in, and the chest expanded. It is said that in severe cases the spasms have been of so violent a character, that muscles have been ruptured, teeth broken, and the tongue lacerated. In the numerous cases of tetanus that I have unfortunately witnessed, it has never fallen to my lot to see any effects of this kind produced; the spasms, indeed, being in general not of a very violent, though of a continuous and very painful character.

The intellectual faculties are not disturbed in these cases, and the mind continues clear to the last. In most cases there are great heat of surface, profuse sweats, and quickness of pulse; not from any febrile disturbance, for this disease is unattended by symptoms of pyrexia, but apparently simply from the violence of the muscular contractions. The prolongation of life appears to depend greatly upon the intensity of the convulsive movements: the more severe these are, the sooner does death result. The fatal termination occurs not so much from any great physical lesion, or disturbance of inportant parts, as from exhaustion, consequent on the frequency of the tetanic spasm.

Pathology.—The morbid appearances found after death from tetanus throw but little light on the real nature of this affection, so little, indeed, that it is frequently looked upon as a "functional disease." But in saying that this or any other disease is functional, we but express our ignorance of its real cause. There is no function without an organ to perform it; and there can be no derangement of a function without a corresponding and concomitant disorder of the organ that produces it. Every "functional" disease must, therefore, at last be referred to an organic lesion. The term "functional" is only employed when we are not acquainted with the true nature of the disease. As less is known of the real physiology and pathology of the brain and spinal cord than of other organs of the body, we have more "functional" diseases of the nervous system than of the circulatory or respiratory. But, as pathological anatomy becomes more studied, and as minute investigations into structure are entered upon, so the class of so-called "functional" diseases becomes narrower. We do not speak of "functional" coma, because we can appreciate the different conditions that occasion compression of the brain; but we still speak of functional convulsive diseases and of functional amaurosis. The ophthalmoscope, however, has shown that functional amaurosis does not exist, but that the failure of visual power is always accompanied by and dependent on some corresponding change of structure in the interior of the eye; and advances in pathology will doubtless show that other so-called functional diseases of the nervous system are in reality dependent on structural lesions. It is true that as yet no specific or positive or invariable derangement of the nervous centres has been met with in tetanus—nothing beyond conditions that are common to many other nervous affections, such as congestion and softening of the brain and spinal cord, possibly with reddish serum in the ventricles and subarachnoid space. But there is one morbid condition that will, I think, invariably be found; viz., a marked congestion and inflammation of the nerve connected with, and leading from, the wound that has occasioned the disease. This morbid state I have never found wanting. In all cases of fatal tetanus that I have seen in which a careful dissection has been made, the signs of inflammation of a nerve communicating with the wound have been found; and the vascularity, which is often very intense, may be traced up the neurilemma, often to a considerable distance.

In a case of tetanus following a wound of the knee, in a patient who died in University College Hospital, a small branch of the internal cutaneous nerve was found to have been injured, and was inflamed. In another patient who died of tetanus about sixteen days after treading on a rusty nail, a black speck was found on the internal plantar nerve, where it had been wounded by the nail. In a man who died of acute tetanus a week after receiving a lacerated wound of the dorsum of the foot, the digital nerves were found to be sloughy, and evidences of inflammatory irritation extended some distance up the musculo-cutaneous nerve. In another case under my care, in which tetanus resulted from a bruise of the back, and terminated in death, the injured nerve (a dorsal branch) was found lying bare and reddened in the wound; and, on tracing it up to the spinal cord, its sheath was found to be much injured, ecchymosed, and with a large vessel running down it. In another instance, in which tetanus followed a wound of the wrist, the external cutaneous nerve was found in a similarly inflamed state.

Treatment.—The treatment of tetanus is of a local and of a constitutional character. The *local treatment* has for its object the removal of the irritation that has induced the tetanic condition. It is true that, when once tetanic excitement has been set up in the cord, it has a tendency to continue, and cannot be removed by the mere abstraction or cessation of the local irritation, which gave rise to it in the first instance. It is, however, only reasonable to suppose, that other treatment will succeed best if local irritation be removed; and, indeed, so long as this con-

tinues to keep up the centric nervous disturbance, no general means can be expected to succeed; as they will have not only to combat already existing disease, but also to overcome the continuous excitement maintained by the local disturbance. Hence, it is of use to bring the wound into as healthy a state as possible, and to see that it is clean, free from foreign bodies, and not inflamed. In order effectually to remove all local disturbance, recourse has been had to amputation; but though this may have succeeded in checking some of the more chronic forms of the disease, yet other and milder local means have sufficed equally well, and in the majority of cases it has had no effect, and hence so severe an operation can scarcely be recommended for adoption. The division of the injured nerve, if there be one that has been punctured or lacerated, has occasionally proved successful. Thus, in a case of tetanus following injury of the supra-orbital nerve, Larrey cut this across, and the patient was cured. In a midshipman, in whom tetanus came on the day after the sole of the foot had been wounded by treading on a rusty nail, Murray divided the posterior tibial nerve, and thus cured the patient. In those cases in which no special nerves appear to have been injured, Liston's recommendation of making a Λ-shaped incision down to the bone, and above the part, so as to insulate it completely, may be advantageously followed. After the nerve has been divided, or the part properly insulated, some solution of atropine may be carefully applied to it, so as still further to lessen local irritation.

In the *constitutional treatment* of the disease, it is necessary to bear in mind that tetanus is an affection of debility, the violence of the spasmodic paroxysms giving an appearance of false strength to the patient; and that the principal source of danger and death is the fatigue and exhaustion induced by the energy of the muscular movements. The means adopted should, therefore, have for their object the removal of irritation and the support of the patient's strength, so as to enable him to hold up against the disease.

In the *acute* form of the disease, all medicines are useless as curative agents. No drug of any kind has as yet cured a case of acute tetanus. But, though medicines are of no avail as means of cure, they may afford relief to the patient; and much may be done by the surgeon, by removing all sources of external irritation, to mitigate his sufferings, and to place him in a favorable condition to withstand the exhaustion and to lessen the torture of the spasms. With this view, the first thing to be done is to clear the bowels well out with a dose of calomel and scammony, or a drop of croton oil; aided, if necessary, by turpentine enemata. The patient should then be kept perfectly quiet in a room by himself, a screen or muslin curtains, as recommended by Marshall Hall, being drawn round the bed; noise or movement of any kind increases the spasms greatly. In order to allay the spinal irritation, the most effectual means consists perhaps in the plan recommended by Todd, of applying an ox's gut or gullet filled with ice along the whole length of the spine. This is a powerful depressing agent, and, unless care be taken, may lower the heart's action too much, or indeed completely extinguish it. It may, however, be applied with safety for six, eight, or ten hours, the condition of the patient being looked to in the meanwhile. Sedative or antispasmodic agents are of no use in acute tetanus. I have seen many drugs of this kind employed without producing any effect in lessening the violence of the convulsions. In most cases, however, the inhalation of ether or chloroform materially lessens their severity, and gives the patient temporary ease.

In the *subacute* or *chronic* form of the disease recovery is much more likely to take place; and it is only in these cases that antispasmodics and sedatives, such as opium, camphor, conium, belladonna, and aconite, have been of use; and in these also, chloroform is far more beneficial than in the acute cases. There is a kind of trismus occurring in females, often of an hysterical nature, which is at once removed by the inhalation of chloroform. Miller speaks highly of cannabis Indica pushed to narcotism; three grains of the extract, or thirty minims of the tincture, being given every half hour or hour; and the Rev. Dr. Haughton has employed nicotine in one-drop doses, administered every second hour, with complete success in severe cases of traumatic tetanus. In one case, at Dr. Garrod's suggestion, I tried atropine endermically on a blistered surface, and gave conium internally in large doses; and although the patient, an old man, eventually died exhausted, yet these agents appeared to exercise a marked influence in diminishing the violence of the spasms, and I should be induced to attach some importance to their administration. Elliot-

son has spoken highly of the preparations of iron, especially of the carbonate, in tetanus. At the same time that recourse is had to such measures as these, it must not be forgotten that the disease is one of great exhaustion, and that the patient will die worn out, unless he be supplied with plenty of nourishment. Beef-tea and wine should, therefore, be administered by the mouth, and nutritious enemata by the rectum; and in this way the powers of life may be supported until the violence of the disease expends itself. I am, however, disposed to think that even in these chronic cases much more may be done by simple than by specific treatment. Clearing out the bowels by turpentine enemata, the internal administration of calomel with opium, and keeping up the powers of the system till the disease wears itself out, appear most likely to be followed by a satisfactory result, when used in addition to the hygienic measures recommended in the acute form of the disease.* It is certainly more rational to employ such measures as these, than to be constantly recurring to antispasmodics and sedatives, which repeated experience has proved to be useless as curative agents, in the vain hope of finding a specific for tetanus.

CHAPTER XXXIX.

DISEASES OF THE LYMPHATICS AND THEIR GLANDS.

INFLAMMATION OF THE LYMPHATICS.

Inflammation of the lymphatics, *lymphatitis*, or *angeioleucitis*, is a diffuse or erysipelatous inflammation of the lymphatic vessels. In it, according to Tessier, the lymph coagulates, forming a rosy clot, which obstructs the interior of the vessel; the walls of which, at the same, become thickened, softened, opaque, and surrounded by a quantity of infiltrated areolar tissue.

Symptoms.—This disease may be idiopathic, when it is closely associated with erysipelas; but more commonly it is set up from the irritation induced by an abrasion or wound. During the progress of an ordinary injury, the patient is seized with rigors, followed by febrile reaction, and attended, perhaps, by vomiting or diarrhœa. These symptoms often precede by twelve or fourteen hours the local signs of the disease, but more commonly accompany them. On examining the part it will, if superficial, be seen to be covered by a multitude of fine red streaks, at first scattered, but gradually approximating to one another so as to form a distinct band, about an inch in breadth, running from the part affected along the inside of the limb to the neighboring lymphatic glands, which may be felt to be enlarged and tender. The band itself feels somewhat doughy and thickened. There is usually more or less œdema of the limb, from the implication of the deeper layers of vessels and their obstruction by the inflammation. Along the course of the inflamed absorbents, erysipelatous-looking patches not unfrequently make their appearance, which coalesce until they assume a considerable size, and constitute a distinct variety as it were of erysipelas. In some cases the glands are affected before any other local signs manifest themselves, owing probably to the deeper seated lymphatics having been first implicated; and not uncommonly throughout the disease the inflammation continues to be confined principally to this set of vessels, giving rise to great and brawny swelling of the limb, but without much if any superficial redness. The constitutional disturbance, at first of the active inflammatory type, may gradually subside into the asthenic form.

Results.—The disease usually terminates in resolution at the end of eight or ten days; not uncommonly it runs on to erysipelas; and in other cases, again, limited suppuration may take place, or a chain of abscesses may form along the course of the inflamed absorbents and in the glands to which they lead. In some instances, after the disappearance of the disease, a state of chronic and rather solid œdema of the part may be left, giving rise indeed to a species of false hypertrophy of it, and constituting a troublesome consequence; more rarely, death results either from erysipelas, from the supervention of pyæmia, or from the occurrence of second-

ary abscesses. This is chiefly in broken constitutions, in which the disease has made extensive ravages, and has become associated with low cellulitis.

Diagnosis.—The diagnosis of inflammation of the absorbents is easy; the only affections with which it can be confounded being erysipelas and phlebitis. From *erysipelas* it may be distinguished by the streaked character and limited extent of the redness; though, as the two affections so commonly occur together, the distinction is of little moment. From *phlebitis*, the disease we are now considering may be recognized by its superficial redness, the inflammation of contiguous glands, and the absence of the knotted corded state, characteristic of an inflamed vein.

Causes.—The causes of inflammation of the absorbents closely resemble those of erysipelas; the disease being especially disposed to by atmospheric vicissitudes, by particular seasons of the year, more especially the early spring, and by the epidemic constitution at the time tending to disease of a low type. So also, the broken health of the patient and the neglect of hygienic precautions tend to induce it. Amongst the more direct causes are wounds of all kinds, but especially such as are poisoned by the introduction of putrid animal matters or other irritants, or that are of recent origin. It is very rarely indeed, that inflammation of the absorbents occurs without some such cause; yet I think we are warranted in considering it as of idiopathic origin in some instances. I have at least seen cases in which careful examination has failed in detecting any breach of surface, or evidence of poisonous absorption.

Treatment.—This consists in the employment of antiphlogistic remedies, such as the application of a series of leeches along the course of the inflamed absorbents, followed by assiduous poppy fomentations; the limb at the same time being kept elevated. The bowels should be freely opened; and if there be much pyrexia present, salines with antimony may be administered. If the fever assume rather a low form, the liquor ammoniæ acetatis may be given in camphor mixture; support being administered or withheld, in accordance with the principles laid down when speaking of the treatment of inflammation generally. If chronic induration and œdema occur, the application of blisters will be found to be of use in taking down the swelling and hardness; bandaging, so as to compress the limb methodically, may be of service in the later stages. If abscesses form, these should be opened early, and treated on ordinary principles.

INFLAMMATION OF LYMPHATIC GLANDS.

Inflammation of the lymphatic glands, or *adenitis*, may occur either from the extension of inflammation along the course of the lymphatics; from the irritation induced by acrid or poisonous substances conveyed along these vessels, and not inflaming them, but inducing diseased action in the glands through which they are carried; or as a consequence of strains resulting from over-exertion, as is often seen in the glands of the groin from walking too much. In whatever way occurring, inflammation of the absorbent glands is always attended by a stasis of the lymph, by coagulation of it; and, if the whole or greater part of the glands of a limb be affected, the course of the fluid through the absorbent vessels may be so seriously interfered with, that œdema, often of a solid character, occurs in the lower parts from which the lymph ought to have been conveyed.

Varieties.—Adenitis may be acute, subacute, or chronic. In *acute adenitis*, which almost invariably occurs as a consequence of angeioleucitis, there are pain, swelling, tenderness, and stiffness about the affected glands, with a dull, heavy sensation in them, followed by all the signs of acute abscess, the glands gradually softening in the centre, and the suppurative inflammation extending to the contiguous areolar membrane, through which it becomes somewhat diffused. In the *subacute adenitis*, which is of common occurrence as a result of injuries or strains, the glands become swollen, enlarged, and tender, and are matted together by the inflammatory and plastic consolidation of the neighboring tissues. If abscess form, it commonly commences in the first instance in the structures around the glands; and these are perhaps eventually exposed at the bottom of the cavity that results. This is especially apt to happen in cachectic and strumous persons from slight sources of irritation. Very commonly, in such subjects as these, the inflammation of the glands runs into a *chronic* state; which, indeed, may at last terminate in their permanent enlargement and induration, or in tuberculous degeneration.

When the glands become chronically inflamed from the first, they will be found to be enlarged and hardened, with tenderness and pain about them: after a time suppuration takes place within them; or perhaps it may occur in the areolar tissue around them, which, breaking down, leaves them in the form of reddish-gray or fleshy masses, that protrude in the midst of the suppurating cavity: as the inflammation subsides, the skin becomes of a reddish-blue or purple hue, is thinned, and firmly incorporated with the subjacent tissues.

Strumous enlargement of glands.—The glands not uncommonly enlarge *chronically* without inflammation, simply as the result of strumous disease or of chronic irritation of some kind. They may remain permanently enlarged, or, after continuing so for months or years, may slowly break down into unhealthy suppuration, leaving the skin thin, blue, and undermined, with weak and often protuberant cicatrices. The pus is curdy and ill-conditioned. In all probability, the peculiar enlargement and tendency to unhealthy suppuration arise from the deposit of tuberculous matter within the gland. These changes principally occur in the neck, especially in the submaxillary glands and the glandulæ concatenatæ, sometimes in the axillary or inguinal glands, forming large indurated and nodulated tumors matted together, and suppurating in the interstices of the areolar tissue, or in the substance of the glands themselves. This strumous enlargement of the glands occurs chiefly in children and in young people; in whom, indeed, it is commonly looked upon as one of the most frequent accompaniments of the strumous diathesis.

Treatment.—The treatment of inflamed absorbent glands varies greatly, according to the stage of the affection. In the *acute stage*, leeches and fomentations are especially required. In the *subacute* condition, spirit-lotions containing the iodide of potassium will subdue the inflammation and take down the swelling; at the same time, the health must be regulated by aperients, and a moderate antiphlogistic plan of treatment. If abscess form, it must be opened with a knife, and the part well poulticed afterwards; the fistulous openings, which are often left, require to be treated by stimulating applications, especially the nitrate of silver, but very commonly they will not heal unless they are slit up and dressed from the bottom.

Chronic inflammation or enlargement of the lymphatic glands, or the induration left as the result of the acute disease, require to be treated on different principles. If there be any pain and tenderness about them, the application of the iodide of potassium and spirit-lotion will be required. If they have already suppurated, and an aperture exist leading down to an indurated mass, or if there be surrounding induration of the soft tissues, it is often a good plan to rub the ulcerated part freely with caustic potass, which will dissolve it away by exciting inflammation around the plastic deposit, and thus causing its dissolution into pus. When there is merely chronic enlargement, without irritation, methodical friction with iodine or iodide of lead ointment will produce absorption of the inflammatory effusion constituting the bulk of the enlargement; and this in many instances may remove the tumor entirely. In other cases, painting the part with the tincture of iodine, and improvement of the general health, will cause the removal of the diseased structure. After abscess has formed and been opened, fistulous openings will be left, into which large masses of hypertrophied gland may be seen to project. These are best reduced by the red oxide of mercury, or potassa fusa; indeed, if the glands be much enlarged and indurated, projecting into the openings made over them, the potassa fusa is the best application that can be made use of, breaking down and dissolving away the indurated mass. In applying it, care must be taken that the caustic do not spread too widely; this may usually be avoided by coating the surrounding integuments with collodion. Extirpation of enlarged lymphatic glands is seldom necessary, and, if undertaken, may lead to more serious and extensive dissections than might appear at first requisite; for a chain of diseased glands often extends to a considerable distance, and after one has been removed, others come into sight. As a general rule, this operation should not be undertaken: cases, however, occasionally occur, in which such a procedure may be deemed advisable, the affected glands being large, indurated, and tuberculous, and their disease of many years' standing; their extirpation may then be proper, and I have not unfrequently had occasion in such circumstances to remove them from the axilla, from the submaxillary region, and from the posterior triangle of the neck.

The lymphatic glands occasionally become much enlarged in the neck, axilla, and groin without any indications of struma, but attended by much debility, and usually

great emaciation; in these circumstances, the best remedies are liquor potassæ in full doses, iodide of iron, and cod-liver oil.

Other Diseases of Glands.—Besides these inflammatory and strumous enlargements of the lymphatic glands, various other alterations are frequently observed in them: thus, they may undergo *cancerous degeneration*, as the result of absorption from a scirrhous, melanotic, or encephaloid tumor. In other cases, again, they have been found to have undergone *calcification*, as the result of tuberculous degeneration; and lastly, a *varicose condition* of the absorbent vessels that pass through them has been observed by Amussat and Breschet: but these are matters of pathological rather than of practical interest.

CHAPTER XL.

DISEASES OF VEINS.

PHLEBITIS.

Inflammation of the veins, originally studied by Hunter, has of late years attracted the attention of many distinguished Continental and British pathologists, amongst whom may be especially mentioned Breschet, Velpeau, Cruveilhier, Arnott, Henry Lee, and Tessier. Phlebitis is of two kinds, *idiopathic* and *traumatic*. The *idiopathic* phlebitis will occur, independently of any external exciting cause, or perhaps from exposure to wet and cold, in one of the large veins, almost invariably those of the lower extremity—the popliteal, femoral, iliac, or saphena. It most usually assumes the *adhesive* form of the disease, and except in individuals of broken constitution cannot be considered dangerous.

The *traumatic* phlebitis is commonly *excited* by the wound of veins, as in operations, venesection, and injuries of various kinds; or it may result from the application of ligatures to them; and it is especially *predisposed* to by a previously unhealthy condition of the blood, by epidemic constitution, and by season—in fact, by those influences that dispose generally to the low and diffused forms of inflammation. It is sometimes adhesive, but not unfrequently suppurative, and is highly dangerous, being often the forerunner and the exciting cause of pyæmia.

Pathology.—When a vein is inflamed, important changes occur both in the coats of the vessel and in the contained blood. The coats of the vessel generally become thickened, the outer one especially being vascular and infiltrated; the inner coat becomes softened, pulpy, and usually more or less stained by the coloring matter of the blood of a dark-red or purple hue. The blood in the inflamed vessel coagulates, and adheres to its sides; this tendency to adhesion and coagulation being increased by the effusion of plastic matter from the wall of the vessel. As a consequence of this, its interior becomes stuffed with a mass of coagulated blood and lymph; sometimes solid throughout, in other cases somewhat tubular, the central hollow being either free or filled with soft blood-coagulum. This coagulation in the interior of the inflamed vein is a very remarkable circumstance, and appears to be specially induced by the morbid action going on in the coats of the vessel; though in many cases it is doubtless aided by the blood becoming entangled in the plastic matter with which the lining membrane of the vein speedily becomes coated. and in other instances it is of the nature of embolism, dependent upon an altered constitution of the blood itself. Suppuration often takes place in the interior of the vein—the pus being produced, not by the transformation of the contained blood, but by effusion from the coats of the vessel. These changes may occur in any vein, external or internal, and we often find them associated—the same vessel containing a mixture of coagulum, fibrine, and pus. The extent of surface which the inflammation may occupy varies from that of a small vessel a few inches in length, to the trunk and branches of one of the largest veins in the body. In accordance with those pathological conditions, three varieties of phlebitis may be described—the adhesive, the suppurative, and the diffuse.

Adhesive Phlebitis.—In this disease, the vein becomes filled by means of a solid plug of coagulum. This may either form primarily in consequence of changes that have taken place in the blood itself, or else secondarily from plastic matter which is thrown out by the wall of the vein; the blood coagulating upon and in this, a firm plug is formed, by which the vessel is more or less completely obstructed. This obstruction of the vessel, which is the common result of this form of the disease, may continue permanently; the plug becoming incorporated with its coats, and gradually undergoing fibro-cellular degeneration, the vein is converted into an impervious cord. In other cases, a channel eventually forms through the axis of this coagulum, allowing the circulation through the vein to be re-established.

Symptoms.—In the adhesive phlebitis the action is usually localized, and limited; very commonly it is idiopathic, but may arise from traumatic causes, and not unfrequently is subacute. When traumatic, it may occur in any vein that is wounded; but, when idiopathic, it commonly occurs in those situated in the calf or leg, especially if they be varicose. The inflamed vein becomes hard, swollen, knobbed, and painful, the knobs constituting distinct enlargements opposite to the valves; if superficial, it presents a reddish-purple color; and there is some degree of stiffness and of inability to move the limb. There may perhaps be no pain when the limb is at rest, but in some cases there are very severe shocks of pain, resembling neuralgia, darting through the limb; and in all cases there is deep tenderness over the course of the vessel. There is always some œdema around the inflamed vein, and in the part that supplies it with blood. This œdematous condition of the limb is a most important diagnostic sign in deep-seated adhesive phlebitis when the vein cannot be felt (as in the pelvis, for instance), and may perhaps be the first symptom observed, coming on either suddenly or gradually. The œdema may give rise to a hard, white, and tense condition of the limb, which pits on pressure, though in some cases the hardness is too great for this. Occasionally, in deep phlebitis, the limb may suddenly swell to a considerable size without there being any subcutaneous œdema. In a case of phlebitis of the deep veins of the leg and thigh, once under my care, the calf of the affected limb suddenly enlarged, with great pain and much distension of the subcutaneous vessels with fluid blood, but without any subcutaneous œdema. As the inflammation subsides, the swelling of the limb goes down, the circulation passing through its former channels, or the blood being carried off by the collateral venous system. If suppuration occur, no change takes place in the symptoms so long as the pus is localized or encysted, unless it perforate the coats of the vein, and, passing into the external areolar tissue, form a common abscess. If it break through its plastic barriers, however, then a very different result occurs, and the symptoms of purulent infection come on. The *constitutional disturbance* in this form of phlebitis is often of a very mild character; if, however, suppuration occur, symptoms of well-marked pyrexia manifest themselves.

The *treatment* of adhesive phlebitis consists in the free application of leeches along the course of the inflamed vessel, with rest of the limb, and fomentations; at the same time salines and purgatives must be administered, and recourse be had to the ordinary antiphlogistic means. If depression come on, carbonate of ammonia must be early given. The hardness which is often left after the removal of the inflammation may usually be got rid of by salt and nitre poultices, as recommended by Basham. If abscesses form, they must be opened whenever they occur. If œdema of the limb continue, the application of blisters, or the pressure of an elastic roller, will remove this troublesome symptom.

Suppurative Phlebitis is always preceded or accompanied by the adhesive form of the disease; the adhesive action bounding and limiting the suppuration, and preventing the pus from becoming mingled with the current of the blood. In this form of the disease, the pus is usually found between the coats of the vessel and the plug, or in a portion of the vessel unoccupied by coagulum, but confined at each end by a mass of plastic matter. If the plastic plug be insufficient to occlude the vessel, or if it become absorbed or metamorphosed into pus, then this fluid may get access to the general circulation, and produce that serious and fatal train of symptoms, constituting pyæmia, and depending on the admixture of pus with the blood. Pus has been described as forming in the centre of the coagulum, at a distance from the coats of the vessels; but Gulliver has pointed out the error of this, by showing that in many cases the fluid described as pus is merely disintegrated fibrine.

Diffuse Phlebitis is an erysipelatous form of the disease, often running for a considerable distance along the coat of the vein, which becomes thickened, pulpy, and red, without adhesions forming or the blood coagulating; indeed, in cases of this kind there appears to be a great want of plasticity in that fluid. This form of phlebitis is commonly, though not always, fatal: its fatality was supposed by Hunter to be owing to the extension of the inflammation to the heart, and by Hodgson to the extent of surface affected; but Arnott has shown that the inflammation scarcely ever reaches the heart, and that the extent of vein inflamed is commonly very limited—it not unfrequently happening that the disease proves fatal when but a few inches are affected, as in the vessels of a stump. Hence it is probable that death is owing either to the admixture of pus with the blood that circulates through the inflamed portion of the vein, or to such changes, induced in the blood by the inflamed surface over which it passes, as are incompatible with life.

Symptoms.—The diffuse phlebitis is ushered in by the ordinary symptoms of pyrexia, at the same time that pain and tenderness, with a certain amount of œdema and hardness, may manifest themselves along the course of the inflamed vessels. These symptoms, however, speedily give way to those that characterize the lowest forms of ataxic fever—such as a fluttering pulse, a brown tongue, sordes about the mouth and teeth, with much anxiety of countenance, diarrhœa, vomiting, extreme prostration, delirium, and death. These symptoms are, indeed, due to the formation of pus in the vein, its admixture with the blood, and consequent poisoning of the system. The whole danger and peculiarity of diffuse phlebitis depend, I believe, upon this circumstance; and I would, therefore, refer for the consequence and treatment of this form of the affection to the chapter on pyæmia (p. 457).

The essential difference between these three forms of phlebitis would appear to depend on the formation and situation of the plastic matter. So long as the inflammation is purely adhesive, or as the pus formed by it is bounded by adhesive plugs, it does not differ in its effect from ordinary inflammation; but, if the pus enter the circulation through the breaking-down or disintegration of these limiting plugs, or if the blood be deeply and seriously altered in its characters by changes induced in its passage over the inflamed surface, then we meet with those peculiar phenomena, indicative of general blood-poisoning, which have been described as pyæmia.

[These statements are scarcely in accordance with the results of investigations of modern pathologists. If pus ever exist in the bloodvessels, it must be looked upon as, in the words of Mr. Savory, "a sort of clinical curiosity." Careful investigation seems to show that the puriform fluid found in veins in cases of pyæmia is composed of the products of disintegrated fibrin, not of pus. (See *St. Bartholomew's Hosp. Reports*, vol. iii., *Virchow's Cellular Pathology*, and even Chapter XXXIII. of the present work, which is much more in accordance with the existing state of science as to pyæmia, than the occasional references to the subject in other parts of the book.)—A.]

VARIX.

By *varix*, or *varicose veins*, is meant a dilated condition of these vessels, with hypertrophy of their coats, giving rise to œdema, tension, weight, and pain in the parts they supply—often with a good deal of numbness, difficulty in motion, or loss of power in the affected limb. In other cases, their pressure on the nerves of the part (as when the veins of the spermatic cord are enlarged) may give rise to very severe suffering.

Appearance.—Varicose veins are tortuous, dilated, and sacculated; they are serpentine in their course, and feel thick under the finger. They may be superficial or deep-seated; when superficial, the disease is often limited to one of the larger venous trunks of a limb, the smaller branches not being engaged. This we commonly see to be the case in the internal saphena; in other cases, the small cutaneous veins alone may be affected, appearing as a close network of a purplish-blue color under the skin, with much discoloration of parts, and some œdema of the limb; or both sets of vessels may be implicated. The deep-seated varix is not by any means so common as the superficial; and, when it occurs, is generally the result of the pressure of a tumor, or of some similar cause. Varicose veins, especially when superficial, are very apt to inflame, with coagulation of the blood within their sinuses.

Locality.—The veins of the skin and the mucous membranes are those that are most liable to this affection. It is most commonly met with in the legs, and more particularly in the trunk of the internal saphena; but any of the superficial veins, as of the arms, chest, head, neck, hypogastrium, or thorax, may be affected. The veins about the anus are especially liable to varix, constituting some forms of pile; so, also, the spermatic veins very often become enlarged, constituting varicocele. As a general rule, superficial varix is infinitely more common in the lower than in the upper part of the body, owing evidently to the tendency to the gravitation of blood in the more dependent situations. When occurring at any point above the pelvis, it may be looked upon as arising, in all probability, from the pressure of a tumor of some kind upon the large venous trunks. The deep-seated veins that are principally affected are, the internal jugulars, the vena azygos, and the veins of the prostate.

Causes.—The causes of varix are generally *such conditions as induce more or less permanent distension of the veins.* Thus, for instance, blows, strains, and habitual over-exertion of a part, by driving the blood into the subcutaneous veins, may give rise to their distension; so also, certain occupations may favor gravitation of blood to the lower part of the body; again, the length of a vein, as of the internal saphena, may occasion its dilatation by the weight of the long column of the contained blood. Any obstacle to the return of the blood from a vein (as the pressure of a tight garter below the knee, or of a tumor upon one of the large venous trunks) may give rise to its permanent distension, as well as to that of all its branches. In other cases the affection, or the disposition to it, appears to be *hereditary;* and in many instances it is difficult to recognize any cause except an *enfeebled and relaxed state of the walls* of the vessel, such as is met with in tall, debilitated and phlegmatic people. *Age* influences materially the occurrence of the disease, which is rare in the earlier periods of life, but gradually increases as the individual advances in years. In *women*, especially, the affection is common; in consequence, partly, of natural debility, but more frequently from the pressure of the enlarged uterus during pregnancy.

Structure.—Varicose veins are sometimes simply dilated, without any thickening of their coats; but in other instances they are truly hypertrophied, their cavity being dilated and their walls thickened—the vessel likewise being elongated, forming curves, and bending back on itself. Sometimes the enlargements at particular points appear to be multilocular, the vein forming a series of curves and dilatations together. The valves are always insufficient in varicose veins, being usually bent backwards or ruptured; and the lining-membrane is marked by longitudinal striæ. The blood in these vessels has a tendency to coagulate in large masses, the vein being at times the seat of inflammation, by which this tendency is materially assisted. The neighboring and subjacent parts are much modified in structure; and there is usually chronic œdema, with infiltration of the skin and cellular tissue, which may at last run into ulceration—giving rise to the varicose ulcer, which has already been described (p. 426), and which, if communicating with a large branch, may yield a copious or even fatal hemorrhage. The blood contained in the varicose knots and veins becomes more or less stagnant, and probably altered in its qualities, so as to render the vessels peculiarly liable to inflammation, and possibly even to influence the state of the general health to a material degree.

Treatment.—This must be conducted on two principles—to palliate and to cure. The *palliative treatment* consists in moderate compression exercised upon the vessel, so as to support its weakened and dilated coats, and thus prevent its further distension and the pain occasioned by this, as well as the other consequences—such as œdema, disorganization, and ulceration of the skin. The pressure must be applied very smoothly and evenly, lest it irritate and ulcerate the skin, or produce distension of the vein below the part compressed. For the purposes of compression, bandages and elastic stockings are commonly employed. In some cases, elastic pressure by means of a vulcanized India-rubber band or garter may be applied around the limb, so as to simulate the action of the valves of the vein; by compression it cuts off the weight of the column of blood from the terminal branches. In other cases, the application of a truss to the upper part of the saphena vein, as recommended by Colles, may be of service.

If a varix burst, violent bleeding may suddenly take place so as to induce faintness, and even death. The copiousness of the bleeding may be accounted for by its

occurring from the *cardiac* side of the varix, the insufficiency of the valves not presenting the ordinary obstacle to the downward flow of blood. The treatment consists in laying the patient flat on the floor and raising his leg, when the hemorrhage will cease. It may be permanently arrested by the pressure of a compress and bandage.

Under certain circumstances it becomes necessary to change the palliative for a *curative* plan. This is especially requisite in the following three conditions: 1, if the varix be of such large size as to produce much inconvenience, or to give rise to severe pain by its pressure on the nerves in its neighborhood; 2, if a varicose vein have burst, or be on the point of giving way; or 3, if an ulcer dependent on its existence will not heal. In one or other of these circumstances, it may be necessary to have recourse to curative treatment. With this view various plans have been recommended; all of which, however, have for their object the obliteration of the vein at one point by exciting adhesive inflammation there, and thus causing it eventually to degenerate into a fibro-cellular cord. In this way the trunk of a varicose vein and the larger masses of varix may be occluded. But can the disease be cured by the local obliteration of the vein? To this question I have no hesitation in answering in the negative. Though the trunk be obliterated, a collateral venous circulation is set up, which is very apt in the course of a few months to take on a varicose condition, and thus to cause a return of the disease some time after the operation. But, though the cure be not radical, much benefit may often be effected by removing varicose knots that occasion pain or inconvenience, by enabling an ulcer to cicatrize, or by occluding a vein from which hemorrhage has occurred. The principle of all curative treatment in varix consists in exciting adhesive and localized inflammation in the vein so as to occlude it, and thus, by directing the blood into other channels, to relieve the distension of the diseased vessels and the inconvenient results that follow this. As the treatment thus necessarily involves the artificial excitation of phlebitis, there is always some little risk of the inflammation passing beyond the adhesive stage into that of suppuration, or diffuse inflammation: but out of upwards of 200 cases in which I have performed these operations, not one has died.

Various plans for obliterating the veins have been recommended by surgeons. They resolve themselves into five principal heads of treatment.

1. The *subcutaneous section* of the vein, or the *excision* of an inch or so of the vessel. This plan of treatment is severe and not unattended by danger, as we learn from Brodie.

2. It has been recommended by Mayo, Seutin, Bonnet, and others, to *excite inflammation in the vein* by producing a series of deep eschars or issues in the skin covering it, by the application of a caustic, such as the chloride of zinc or potassa fusa. Skey speaks very favorably of this mode of obliterating varicose veins, as being devoid of danger. He recommends the eschars to be made by the application of a powder, composed of three parts of lime and two of potass, made into a paste with spirits of wine at the time of application. The eschars should not be larger than a split pea, and their number must depend on the extent of the disease.

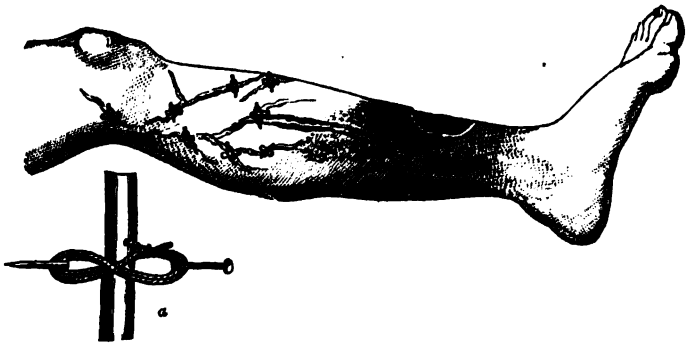
3. Others recommend the obliteration of the vessel by *introducing needles into it*, and *transmitting a galvanic current* along and across them. Of this plan of treatment I have not had any experience; nor do I believe that it is ever employed by surgeons in this country.

4. *Injection of the varix by a few drops of a solution of the perchloride of iron*, as recommended by Pravaz, is a very effectual method of procuring coagulation of the contained blood and consolidation of the varix, more particularly if it be of a very large size and cellular. In employing this means, it is better to compress the vein by means of the finger or a pad and bandage above the varix; the solution is then to be injected in very small quantity—not more than three or four drops—by means of the syringe (which will be described in speaking of the treatment of nævus), into the dilated veins. Coagulation of the blood immediately takes place. The patient must be confined to his bed for a few days with the limb raised, and a bandage should be applied before he is allowed to walk about. This means is very effectual in large varix, and may in such cases be advantageously conjoined with the next method—the pins being used under the venous trunks, and the solution introduced into the dilated masses of the varix. But it is not devoid of danger:

accidents, such as local suppuration and sloughing, pyæmic symptoms, and even embolism, have followed its use.

5. The most convenient and safest way of obliterating the vein in my opinion, and that which I always employ, consists in *compressing the vessel at several points*, by *passing a hare-lip pin underneath it*, laying a piece of wax-bougie over it, and then applying the twisted suture around the pin and over the bougie (Fig. 220, *a*). In this way the vessel gradually ulcerates by the pressure that is exercised upon it, and the presence of the bougie prevents the ligature from injuring the skin. In performing this operation, care must be taken that the vein be not transfixed, but

Fig. 220.



Application of pins to varicose veins.

that the pin be pushed, or rather dipped, underneath it; the ligature should not be too thin, and must be applied tightly over the bougie; several pins (as many as eight or ten, if necessary) should be introduced along the course of the same vessel, at distances of about three-quarters of an inch from one another (Fig. 220); those highest up should be put in first, and they should be left in for at least a week or ten days, by which time the obliteration of the vessel will have taken place. I believe that all the danger of the operation consists in the transfixion of the vein by the pin; the operator may always know when he has done this by the escape of a few drops of venous blood; when the pin is properly passed under the vein, the operation is a perfectly bloodless one. If the vein be transfixed, the pin should immediately be withdrawn and passed at another point; if it be allowed to remain in the vein, it will act as a foreign body, and suppurative phlebitis will ensue. When the vein is properly compressed between the pin below and the bougie above, adhesive inflammation takes place in it, and it becomes obliterated at the point of pressure. By attention to these circumstances I have never met with any ill-consequences, either from suppurative phlebitis or pyæmia, in any of the cases in which I have performed this operation, which are between 200 and 300 in number.

In addition to the application of the pins in the usual way, H. Lee has recommended the subcutaneous division of that portion of the vein which is included between them, after coagulation of the blood has taken place. This I have found to be an useful addition to the ordinary treatment, and to insure the obliteration of the vessel.

The points of the pins may be prevented from pressing injuriously upon the skin, by putting small pieces of adhesive plaster under them. The powers of the constitution should at the same time be improved, and the activity of the circulation kept up by nourishing diet, tonics, and wine. Whilst the pins are in, the patient must not be allowed to move about, and after they have been taken out the limb should be bandaged for some time. In general, no ulceration takes place about the pinhole apertures; but occasionally, in debilitated constitutions, a sore forms, which requires to be treated on ordinary principles.

CHAPTER XLI.

ANEURISM BY ANASTOMOSIS, AND NÆVUS.

ANEURISM BY ANASTOMOSIS.

Aneurism by anastomosis is a disease of the arteries, in which the vessels become excessively elongated, tortuous, and serpentine; sometimes they assume a varicose condition, being dilated into small sinuses, and are always very thin-walled, resembling rather veins than arteries in structure. This kind of dilatation of the vessels will give rise to pulsating tumors, often of considerable size, and of a very active and dangerous character. They may be situated in almost any tissue or organ of the body, but are most commonly met with in the submucous and subcutaneous areolar tissue, and most frequently occur in the upper part of the body, especially about the scalp, orbit, lips, and face; but they have been met with in other situations, such as the tongue, and even in internal organs, as the liver; and I have seen very active growths of this kind on the side of the chest, nates, and foot. In some cases, aneurism by anastomosis occurs in bones, in which it forms a special disease, and is not uncommonly associated with encephaloid. Indeed, there is certainly a great tendency for aneurism by anastomosis and encephaloid to run into one another; the limits between them not being very clearly defined, especially when they occur in connection with osseous tissue. It will generally be found that the arteries leading to the aneurism by anastomosis, though at a considerable distance from it, are tortuous and enlarged, with thin and expanded coats, and pulsate actively; in fact, constituting that condition that goes by the name of *cirsoid dilatation* of the vessels.

Aneurism by anastomosis forms tumors of varying magnitude and irregular shape; they are usually of a bluish color, have a spongy feel, are readily compressible, not circumscribed, and have large tortuous vessels running into and from them on different sides. Their temperature is generally above that of neighboring parts; and a vibratory or purring thrill, amounting in many cases to distinct pulsation, may be felt in them. This pulsation or thrill is synchronous with the heart's beat, may be arrested by compressing the tumor or the arteries leading to it, and returns with an expansive beat on the removal of the pressure. The bruit is often loud and harsh, but at other times of a soft and blowing character. These growths rarely occur in infancy, but generally make their appearance in young adults, though they may be met with at all periods of life, often as the consequence of an injury of some kind.

Diagnosis.—It is of importance to effect the diagnosis between *ordinary aneurism* and that by anastomosis. In many cases the situation of the tumor at a distance from any large trunk, as on the scalp, the outside of the thigh, or the gluteal region, will determine this. Then, again, the outline of the growth is less distinct than in true aneurism; and tortuous vessels will be felt leading to it from different directions. The swelling also is doughy and very compressible; but, when the pressure is removed, the blood enters it with a whiz and thrill, not with the distinct pulsating stroke that is found in aneurism. The pulsation, not so forcible as in aneurism, is more heaving and expansive. The bruit is louder, and more superficial, sometimes having a cooing note. By pressure on the arteries leading to the tumor these signs are usually not entirely arrested, though diminished in force, the blood entering it from the neighboring parts, and in a less direct way.

Treatment.—The treatment of aneurism by anastomosis must depend upon the size and situation of the growth. When it is so placed that it can be *ligatured* or *excised*, as on the lip, or when of small size, about the neck, face, or scalp, trunk, or extremities, it should be removed in one or other of these ways. I always prefer the ligature, applied as will immediately be described, as being the safest, and upon the whole the readiest mode of getting rid of such a tumor. If excision be prac-

tised, it is necessary to be very careful to cut widely of the disease; if it be cut into, fearful hemorrhage may ensue, which can only be arrested by pressure, and which in several instances has proved fatal.

If the disease be very large and extended, as is commonly seen on the scalp, or if deeply seated, as in the orbit, neither ligature nor excision of the tumor can be practised, and it becomes necessary to starve it by cutting off its supply of blood. This may be done either by *ligaturing the principal branches leading to it*, or *the main trunk* of the limb or part.

Simple ligature of the *arterial branches leading to the tumor* has never, I believe, been followed by success; at least, in ten recorded instances in which it has been had recourse to, the disease has not in one instance been cured. It has, however, been successfully conjoined by Gibson in two cases of aneurism by anastomosis of the scalp, with incisions made round the tumor at intervals between the principal feeding arteries, which at the same time were tied.

The *main trunk* leading to the tumor has been ligatured in a considerable number of cases. The brachial and femoral arteries have been tied for disease of this kind situated on the extremities, and in some instances with success; but the carotid is the vessel that has been most frequently deligated, in consequence of the tumor being so commonly situated on the scalp and in the orbit. This operation has been done in twenty-three recorded cases, and in five instances both the carotids were ligatured at intervals of several weeks. In all of those cases in which the double operation was performed, the patients ultimately recovered. In some of the cases in which one carotid alone was tied, the disease, being seated upon the scalp, was not cured; and it was afterwards found necessary to have recourse to ligature of the tumor, to excision, and to other means of removal; indeed, when seated upon the scalp, this disease appears to be more intractable than in any other part of the body, owing probably to the freedom of the arterial supply from the numerous vessels that ramify in this region. Here, however, much benefit might be derived after ligature of the carotid, by adopting the plan suggested by Gibson of tying the feeding arteries, and making incisions between them down to the bone. The ligature of the carotid has answered best for diseases of this kind in the orbit; of thirteen instances in which the artery has been tied for aneurism by anastomosis in this situation, a cure was accomplished in the majority.

NÆVUS.

This disease, under which are included those various affections termed *mother's marks*, *erectile tumors*, and *vascular growths*, constitutes an important and interesting section of surgical affections. It appears to consist essentially in an excessive development of the vascular tissue of a part, and differs greatly as to nature, cause, and treatment; according as the arterial, the capillary, or the venous elements of the tissue predominate. The predominance of the arterial tissue we have already considered, under the head of aneurism by anastomosis; it now remains for us to describe the capillary and venous nævi.

Capillary Nævi appear as slightly elevated but flat spots on the skin, of a bright red or purplish tint, and having occasionally granular or papillated elevations, with some larger vessels ramifying on their surface. They often spread superficially to a considerable extent; they are usually situated on the face, head, neck, or arms, but occasionally, though more rarely, on the back, the nates, the organs of generation, and the lower extremities. They are, I believe, always congenital, though often at birth of a very small size, not larger than a pin's head, from which they may spread in the course of a few weeks or months to patches an inch or two in diameter. In many cases no inconvenience results from this disease except the deformity it entails; but occasionally, more especially when the growth is at all prominent, there is a great disposition to ulceration of an unhealthy and hemorrhagic character. When bleeding occurs, it is usually in a trickling stream, and without any degree of force.

Venous Nævi are of a dark purple or reddish color, usually very prominent, and often forming distinct tumors of considerable size, which may either be smooth and ovoid, or else somewhat lobulated. On compressing a growth of this kind, it subsides to a certain extent, feeling doughy, soft, and inelastic, and on the removal of the pressure fills up again. In some cases, when consolidated by inflammation,

or containing cysts, it cannot be lessened in bulk by pressure. These nævi are usually of about the size of half a walnut, but sometimes much larger. I have removed them from the nates and the back fully as large as an orange. They less frequently occur upon the head and face than the capillary form of the disease; most of the instances that I have seen have been met with in the lower part of the body, about the nates, back, lower extremities, and organs of generation.

Subcutaneous nævi are occasionally met with, of a *mixed character*, forming soft, doughy, and compressible tumors, which may be recognized by being capable of diminution by pressure, on the removal of which they slowly fill out again to as large a size as before; they also become distended when the child screams or struggles, and are usually of an oval shape, smooth and uniform. The skin covering the tumor is often unaffected; at other times it is implicated in an oval patch on the most prominent part of the growth, and occasionally the surrounding veins are bluish and enlarged.

Structure.—Capillary nævi appear to be composed of a congeries of small tortuous vessels, of a capillary character; venous nævi appear made up of thin tortuous veins, dilated into sinuses and small pouches. In the midst of these masses, cysts are not uncommonly found, sometimes containing clear, at other times a dark, sanguinolent fluid. These cysts are probably venous sinuses, the openings into which have become occluded.

Treatment.—In the treatment of nævus, the first point to be determined is whether the case should be left to nature, or whether operative measures should be had recourse to. In deciding this point we must be guided by the size, situation, and character of the morbid growth. If this be small, cutaneous, and superficial, so situated that it occasions little or no disfigurement, and if it show no tendency to increase, it may be left without interference; when it may eventually shrivel and disappear, or become converted into a kind of mole. In some cases this process may be hastened by the application of tincture of iodine or liquor plumbi. In other cases, again, the nævus, though cutaneous and superficial, is so widely diffused over the surface, that no attempt at its removal or destruction can be entertained with prudence.

Fig. 221.

Syringe for injecting nævus.

But, if the nævus be large, if it be subcutaneous, or if it increase in size, or if it be so situated as to occasion disfigurement, means must then be adopted for its removal by operative procedure.

Operations for the removal of nævi may be conducted on four principles: 1, to excite adhesive inflammation in them, and so to produce plugging and obliteration of the vascular tissue of which they are composed; 2, to destroy the growth by caustics; 3, to remove it with the knife; or 4, to remove it by ligature. Each of these different plans of treatment is peculiarly applicable when the disease assumes certain forms, and affects certain situations.

1. When the nævus is of small size, and occurs in such situations that its destruction by caustics, or removal by knife or ligature, would be attended by serious deformity, as when it is seated about the eyelids, upon the tip of the nose, at the inner angle between the eye and the nose, or about the corners of the mouth, it is best to endeavor *to procure its obliteration, by exciting adhesive inflammation in it.* This may be done in various ways. If small, the nævus may be vaccinated. If it be larger, the most convenient plan consists, perhaps, in passing a number of fine silk threads across the tumor in different directions, and leaving them in for a week or two at a time, until they have produced sufficient inflammation along their tracks, then withdrawing them and passing them into other parts of the tumor. In this way its consolidation may gradually be effected. Another very useful plan is to break up the substance of the growth subcutaneously by means of a cataract-needle, or tenotome, and, in the intervals between the different introductions of this instrument, to keep up pressure upon the tumor. In other cases, again, the requisite amount of consolidation will be induced by passing acupuncture-needles into the nævus, and then heating them by means of a spirit-lamp. Perhaps the most efficient way of obtaining this object is by injecting the perchloride of iron by means of a small glass syringe with a screw-piston rod and a fine sharply-pointed nozzle (Fig. 221). In doing this, care must

be taken that but a very small quantity of the solution, not more than two or three drops, be injected at one time. The perchloride of iron possesses extraordinary power of coagulating the blood; and, if more than has just been mentioned be thrown in, the tissue of the nævus may either have its vitality destroyed, and slough, or coagulation of the blood in the vessels beyond the nævus may occur, and a dangerous or even fatal embolism ensue from the coagulum thus formed being washed into the current of the circulation.

2. When the nævus is small, very superficial, of the capillary character, with an exceedingly thin covering of cuticle, and so situated, as upon the arm, neck, or back, that a moderate amount of scarring is of little consequence, it may most conveniently be removed by the *free application of nitric acid*. This should be well rubbed on by means of a piece of stick; and, after the separation of the slough produced by it, its application must be repeated as often as there is any appearance of the granulations springing up, which occasionally happens at one angle of the wound, and indicates a recurrence of the vascular growth.

3. When the nævus is of large size, constituting a more or less distinct tumor, and is of a somewhat venous character, it may occasionally be *excised*. Teale, junior, has shown that some nævi which are distinctly encapsuled may readily be dissected, or rather shelled out. Should the nævus, however, be diffused, without any distinct limiting capsule, care should be taken to cut wide of the disease; and no operation with the knife should be undertaken unless the growth be either so situated, as upon the lip, that the parts may readily be brought or compressed together, or upon the nates or thigh, where it is unconnected with large bloodvessels, and is also of a very indolent and venous character. If the nævus be arterial, or partake of the nature of aneurism by anastomosis, it should not be touched with the knife. It is especially when the nævus is of the lipomatous or cystoid character or is distinctly encapsuled, that excision may be advantageously practised.

4. As a general rule, it is far safer and more convenient to extirpate the growth with the *ligature;* and this, indeed, is the mode of treatment that is most generally applicable to tumors of this kind in whatever situations they may occur, as it effectually removes them without risk of hemorrhage, and leaves a sore that very readily cicatrizes.

The ligature requires to be applied in different ways, according to the size and situation of the tumor. In all cases, the best material is firm, round, compressed whip-cord. This should be tied as tightly as possible, and knotted securely, so that there may be no chance of any part of the tumor escaping complete and immediate strangulation. It is well, if possible, not to include in the noose any healthy skin, but to snip across with a pair of scissors that portion of integument which intervenes between the cords that are tied together; at the same time, care must be taken to pass the ligatures well beyond the limits of the disease.

When the tumor is small, an ordinary double ligature may be passed across its base, by means of a common suture-needle; and, the noose being cut and the thread tied on each side, strangulation will be effected. When it is of larger size, and of round shape, the most convenient plan of strangulating the tumor is that recommended by Liston. It consists in passing, by means of long nævus-needles, fixed in wooden handles, and having the eye near their points, double whipcord ligatures in opposite directions across the tumor; then cutting through the nooses, and tying together the contiguous ends of the ligatures until the whole of the growth is encircled and strangled by them. In doing this, a few precautions are necessary: thus, the first nævus-needle should be passed across the tumor unarmed (Fig. 222, *a*), and used to raise up the growth somewhat from the subjacent parts. The second needle, armed as represented in the diagram (Fig. 222), carrying the whipcord ligature by means of a piece of suture-silk, should be passed across the tumor in the opposite direction to, but underneath the first needle; the armed needle being withdrawn, the ligature is carried across; and the first one, having been armed in the same way, carries its noose through the tumor as it is drawn out. The two nooses having then been cut, an assistant must seize, but not draw upon, six of the ligature ends; the surgeon, then, having divided the intervening bridge of skin, ties rather tightly, in a reef-knot, the two ends that are left hanging out; as soon as he has done this, he proceeds to the next two, and so on to the last (Fig. 223). When he ties these, he must do so with all his force, especially if the tumor be large, as by drawing on them he tightens all the other nooses, and drags the knots

Fig. 222.

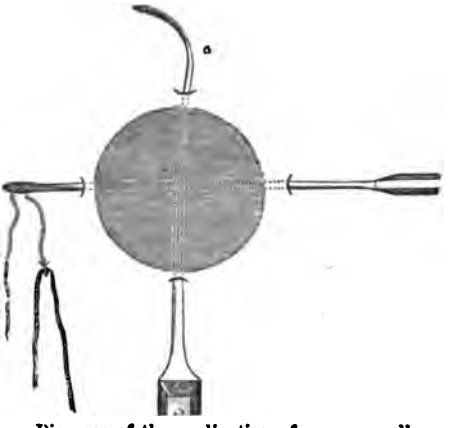


Diagram of the application of nævus-needles.

towards the centre of the growth, which is thus effectually strangled. He then cuts off the tails of the ligature. After the tumor has sloughed away, which happens in a few days, if properly and tightly strangled, the sore is treated on ordinary principles. If the nævus be altogether

Fig. 223.

Diagram of nævus tied.

subcutaneous, the skin covering it should not be sacrificed, but, being divided by a crucial incision, may be turned down in four flaps, and the ligature then tied as directed.

In some cases, the nævus is so flat and elongated that the application of the quadruple ligature, as above described, cannot include the whole of it. Under these circumstances, I have found the ligature about to be described eminently useful, having successfully employed it in a great number of instances. Its great advantage is that, while it completely and very readily strangles the tumor, it does not inclose an undue quantity of integument, and thus does not produce a larger cicatrix than is necessary for the eradication of the disease. It is applied in the following way. A long triangular needle is threaded on the middle of a whipcord about three yards in length; one half of this is stained black with ink, the other half is left uncolored. The needle is inserted through a fold of the sound skin, about a quarter of an inch from one end of the tumor, and transversely to the axis of the same. It is then carried through, until a double tail, at least six inches in length, is left hanging from the point at which it entered; it is next carried across the base of the tumor, entering and passing out beyond its lateral limits, so as to leave a series of double loops about nine inches in length on each side (Fig. 224). Every one of these loops should be made about three-quarters of an inch apart, including that space of the tumor; and the last loop should be brought out through a fold of healthy integument beyond the tumor. In this way we have a series of double

Fig. 224.

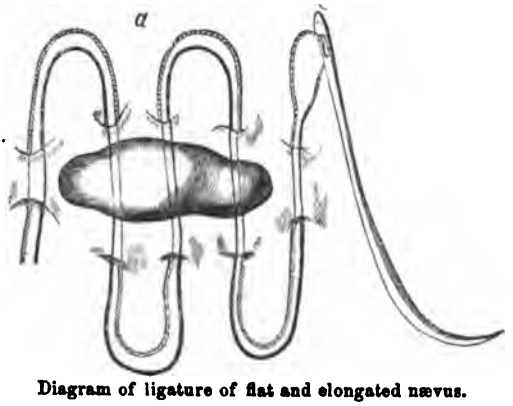


Diagram of ligature of flat and elongated nævus.

Fig. 225.

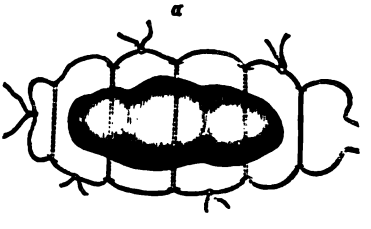


Diagram of flat and elongated nævus tied.

loops, one *white*, and the other *black*, on each side (Fig. 224). All the *white* loops should now be cut on one side, and the *black* loops on the other, leaving hanging

ends of thread of corresponding colors. The tumor may now be strangulated by drawing down and knotting firmly each pair of *white* threads on one side, and each pair of *black* ones on the other. In this way the tumor is divided into segments, each of which is strangulated, by a noose and a knot: by *black* nooses and *white* knots on one side, by *white* nooses and *black* knots on the other (Fig. 225).

The cicatrix resulting from the removal of a nævus is usually firm and healthy; but, in some instances, I have seen it degenerate into a hard warty mass requiring subsequent excision. The ligature may be used successfully at all ages. I have repeatedly tied large active nævi in infants a month or two old without meeting with any accident.

Nævi in Special Situations.—*Nævi of the scalp* are more frequent than in any other situation, except, perhaps, the face. When occurring on those parts that are covered by hair, they are almost invariably prominent and subcutaneous; when seated on the forehead, or on the bare skin behind the ears, they are often cutaneous, The ordinary subcutaneous nævus of the scalp is readily removed by the application of the *quadruple ligature*. In general, it is better not to attempt the preservation of any of the integument covering the growth. It is true that, when removed, a clean white cicatrix is left which never covers itself with hair; but this contracts, and in after-life becomes but little visible. The attempt to dissect down the skin that covers the nævus is not only troublesome, but is attended by a very considerable, and possibly a dangerous amount of hemorrhage. Those flat nævi that are situated behind the ear are best treated by the free application of fuming nitric acid.

Nævus of the fontanelle is the most important variety of the scalp-nævus, and constitutes a somewhat formidable disease. A large purple tumor is situated within the anterior fontanelle, rising and falling with the pulsations of the brain communicated to it, and becoming distended and tense when the child cries. The tumor is evidently close upon the membranes of the brain, and may be looked upon almost as an intracranial rather than a scalp-tumor. The close proximity of the tumor to the brain and its membranes often deters practitioners from interfering with it; and I not unfrequently see cases in which the parents of the child have been counselled not to allow any operation to be practised, lest death should result. Yet this tumor, so formidable in appearance, and so deeply seated, close upon the brain, and as it were within the cranium, may be removed with the most perfect safety by the *ligature*. I have often tied nævi in this situation, and have never seen any ill consequences, not even a convulsive fit, occur. The danger, then, from the mere strangulation of the tumor in this situation cannot be great; but there is another and a special danger, viz., the risk of wounding the membranes of the brain in passing the ligatures under the base of the tumor. If nævus-needles, or sharp pointed instruments of any kind be used, this accident will be very likely to occur; and, if this were to happen, inevitably fatal consequences must ensue. This accident may always be avoided by operating in the following way. A puncture is made in front of the tumor through the healthy scalp. An eyed probe, armed with a double ligature, is then pushed through this opening across the base of the tumor, and its end is made to project on the opposite side beyond it; here another puncture is made, and the probe and ligature together are drawn through. The same procedure is adopted across the tumor sideways. In this way, a quadruple ligature is passed across the tumor in two opposite directions; the ends are then disengaged, and the ligature is tightened in the ordinary way.

Nævi of the face are of very common occurrence, and usually cause much disfigurement. The treatment to be adopted necessarily varies greatly, according to the nature of the nævus, whether cutaneous, subcutaneous, or both; and especially according to its situation. The same plan, which is advantageously adopted in one part, may be altogether inapplicable in another. We shall, accordingly, consider the treatment of these vascular growths, as they affect the eyelids, the nose, the cheeks, and the lips.

Nævus of the eyelids is usually cutaneous, consisting of a discoloration or staining, as it were, of the lid, without any material swelling of it. Such a disease is, I think, better left untouched; it cannot, of course, be removed either by the knife or by caustics, without producing worse results; and, as the skin is always deeply involved, milder means are inoperative, or possibly equally destructive. I have heard of sloughing of the eyelid being occasioned by the use of astringent injections in such cases; though, if the nævus were subcutaneous, and constituted a distinct tumor,

passing perhaps into the orbit, injection with the perchloride of iron might advantageously be adopted.

Nævus of the nose may occur in two situations—at the root, or towards the alæ and apex. When seated at the root of the nose, upon the bridge, or at the lower part of the forehead, between and perhaps extending above the eyebrows, it is often subcutaneous, and may attain a very considerable magnitude. In cases of this kind, I have found the *quadruple ligature* the readiest means of removal; and although the part included may be of large size, the resulting cicatrix is wonderfully small and narrow, usually becoming horizontal, so as to fall into the folds of skin naturally existing in that situation. In the case of a little girl about three years of age, brought to me some years ago by my friend Dr. Gerber, I removed a nævus that was cutaneous as well as subcutaneous, and as large as a walnut, from this situation, by means of the quadruple ligature, with the most satisfactory result, the resulting cicatrix being remarkably small; and in another little girl, from the bridge of whose nose I removed, some years ago, a nævus as large as a marble, very little scarring or deformity resulted. In both these cases, the nævus was cutaneous as well as subcutaneous. If the skin be not affected, injection of perchloride of iron may be advantageously employed in such cases. When the tip and alæ of the nose are affected, the nævus being cutaneous, we can seldom do much to improve the appearance of the patient. In such cases, I have tried breaking down the nævus, and the galvanic cautery, without any material benefit; the destruction of the tissues soon afterwards leading to deformity in the organ. When the nævus is subcutaneous, occupying the tip, alæ, and columna nasi, injection with perchloride of iron is the only means that I have found of real service. In doing this, care must be taken not to throw in too much of the liquid, lest sloughing result.

Nævi of the cheeks may occur in three distinct forms. 1. There may be a simple cutaneous nævus, a mere staining of the skin, a "mother's mark." This admits of no treatment; and the subject of it must submit to continue through life to exhibit the characteristic discoloration. 2. The elevated nævus is raised above the surface, and is of a deep purplish-red or plum color, covered with a very thin integument. In this form of the disease, I think that the application of concentrated nitric acid is the best means of extirpation. By one or two free applications of the caustic, the nævus growth is removed, and a dense white cicatrix, presenting little disfigurement, is left in its place. 3. The nævus may involve the whole thickness of the cheek, being scarcely, if at all, cutaneous. Nævi of this kind cannot, of course, be extirpated, either by the knife, ligature, or caustics, lest the cheek be perforated, and the most serious disfigurement ensue. In such cases as these, we must endeavor to obliterate the structure of the nævus by exciting inflammation in it by means of setons, or by breaking down the structure of the growth with cataract-needles or a fine tenotome. In a case which I attended some years ago, with my friend Mr. Bartlett of Notting Hill, a large and deeply seated nævous growth, which occupied one cheek, was cured by having a number of fine silk threads passed across it in different directions, and then being gradually, piece by piece, broken down with a cataract-needle; no disfigurement whatever being left.

Nævi of the lips require different treatment, according as they occupy the margin or have involved the whole substance of these parts. When seated at the margin, as projecting and somewhat pendulous growths, they may very readily be removed by a double or quadruple ligature, according to their size. This was the practice pursued in the case from which the accompanying drawings (Figs. 226, 227) were

Fig. 226.

Nævus of lower lip: Front view.

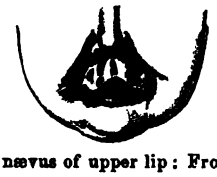
Fig. 227.

Nævus of lower lip: Side view.

taken, where a most excellent result was obtained by the use of the ligature, followed at a later period by injection of perchloride of iron into some of the more

widely diffused parts of the nævous growth. When the nævus involves the whole thickness of the lip, such measures are not always available. If it deeply invade the substance of the lips, an operation somewhat similar to that for the removal of a cançroid growth might be practised; the whole substance of the lip being cut through widely on each side, and the edges of the incision brought together with hare-lip pins. Such an operation is only practicable when the disease, though deeply seated, does not spread to any very great extent laterally. When it does, the whole of one-half of the lip, for instance, being involved, the use of the knife, especially in young infants, would be too hazardous, on account of the probability of serious hemorrhage; and other means must be employed. I have tried the use of setons, and of injections with perchloride of iron; but not with any advantage. When the whole substance of the lip is involved, inclusion and strangulation of the morbid mass by means of the ligature is seldom available; the amount of sloughing being very great, and the child, absorbing the putrescent matters from the sloughing mass which results, incurring the danger of being poisoned from this source. In an infant with a very large nævus, including one-half of the lip, which I ligatured at the hospital some years ago, death appeared to result from this cause. One of the most formidable cases of nævus of the lip that I have ever had to do with, and in its results the most satisfactory, was sent to me several years ago, by Dr. Budd, of Barnstaple. The patient, a little girl five months old, was noticed at birth to have a red streak on the right side of the upper lip; this rapidly developed into a large tumid purple nævus, which, when the case came under my observation, was of about the size of a large walnut, involving the whole of the structures of the lip, from the cutaneous to the mucous surfaces; it was of a deep mulberry color, and extended from the median line of the lip to the angle of the mouth (Figs. 228, 229).

Fig. 228.



Large nævus of upper lip: Front view.

Fig. 229.

Large nævus of upper lip. Side view.

The integuments covering this growth were exceedingly thin, and the tumor itself was in the highest degree vascular and active. Excision appeared to be out of the question; the ligature presented little to recommend it; injections with the perchloride of iron and the introduction of setons were successively tried, but neither of these means produced any effect on the tumor, which commenced to extend upwards into the nostril. I accordingly determined on using caustics. Nitric acid was first employed; but, as this did not produce sufficiently deep impression on the growth, I had recourse to the potassa cum calce. By means of this, the tumor was gradually removed; the hemorrhage which occasionally resulted being restrained by pressure. Notwithstanding the amount of tissue destroyed, the resulting cicatrix was small, resembling that of a badly united hare-lip. Three years afterwards, the child was brought to me again, and I was much struck by the wonderful improvement that had taken place since the removal of the nævus. The lip was smooth, the cicatrix in a great degree worn out, and comparatively little disfigurement was left in the countenance of an exceedingly pretty and engaging child. Finding, however, that the lip was still drawn or tucked in by a very dense band of cicatricial tissue, which caused a deep depression of the ala on that side, I divided this, and the result was of the most satisfactory character.

Fig. 230.

Nævus of tongue.

Nævus of the tongue is of rare occurrence. I have, however, successfully operated by means of the écraseur in one case, in which the whole of the free extremity of the organ was involved (Fig. 230). The particulars will be found in Chapter LVI.

Nævi of the organs of generation are occasionally met with in the female, but rarely in the male. The only instance of *nævus of the penis* with which I have met occurred in the case

growth of this kind, as large as a walnut, situated under the reflexion of the preputial mucous membrane. It had existed for many years without giving any annoyance, but, as it had of late begun to enlarge, and occasionally to bleed, he was desirous to have it removed. This I did by applying the quadruple ligature, after having dissected down to the mucous membrane.

Nævi of the vulva and pudendum are by no means of very unfrequent occurrence. We have had several instances of the kind in the hospital of late years. They are usually of a venous character, often attain a large size, and may sometimes involve the integumental structures on the inside of the thigh, or on the perineum, as well as the vulva. When the growth is confined to the vulva, it is best removed by the ligature. Some time ago, I removed in this way a large venous pendulous nævus, as large as two or three flattened walnuts, from the left labium of a little girl six years of age. In this case, I found it most convenient to employ the continuous ligature. The same means were had recourse to in order to extirpate a large nævus from the labium of a child three years of age; but in this case the disease extended to the integuments of the perineum and inner side of the thigh, and was here removed by the application of strong nitric acid, after the larger growth had separated.

On *the extremities, neck, and trunk* every possible variety of nævus occurs. When the disease is flat, consisting rather of staining of the skin than of any actual tumor, it may commonly be treated successfully by the application of the strong tincture of iodine; or, should it be thought desirable to remove it, this may be effected by rubbing it with strong nitric acid. If the nævus assume the form of a tumor, it will almost invariably be of a venous character, and then removal by means of the ligature should be effected. If the growth be round, the ordinary quadruple ligature may be employed; if flat or elongated, the longitudinal continuous ligature is preferable.

Nævoid Lipoma.—This is a form of nævus with which I have occasionally met, but which does not appear to have attracted much notice, although I find that Nélaton speaks of it. It is a tumor in which the nævoid structure is conjoined with or deposited in a cellulo-fatty mass. This disease is invariably seated upon the nates, back, or thigh. It occurs as a smooth, doughy, indolent tumor, incompressible, not varying in size or shape, without heat, thrill, or pulsation of any kind, possibly having a few veins ramifying over its surface, but no distinct vascular appearance. It is usually congenital, or has been noticed in early childhood; and continues without any very material change in shape, size, or appearance, until the inconvenience or deformity occasioned by it requires its removal. This is best effected by the knife. After removal, the tumor will be found to be composed of a cellulo-adipose basis, having a large number of veins ramifying through it, so as to constitute a distinct vascular element, communicating with small cysts containing a bloody fluid. The tumor has occasionally a tendency to recur after removal. In one case I have operated three times for the removal of a large growth of this description, situated on the buttock, and extending forward towards the perineum. The first operation was performed in 1851; the second in 1856; and the patient, then eighteen years of age, again presented himself in 1863 with a recurrence of the growth in an ulcerated state, in the cicatrix of the former operations. The situation in which I have seen such tumors occur, where they gave rise to most inconvenience, and where their removal has required the greatest care, has been the anterior part of the thigh, just below Poupart's ligament, close upon and almost in connection with the femoral vessels. In a case of this description, which was sent to me by my friend Dr. Edwards of Antigua, the patient, a gentleman of that island, had suffered from a chronic solid œdema of one of his legs for some years, apparently dependent upon the pressure exercised upon the saphena and femoral veins by an elongated indolent tumor just below Poupart's ligament, and over the course of these vessels. This tumor had existed from childhood, and presented the signs that have just been given as characteristic of the disease under consideration. It was removed by an incision parallel to Poupart's ligament, some careful dissection being required to separate it from the femoral sheath, more particularly towards the inner side, where a prolongation of the tumor dipped down by the side of the femoral vein, doubtless compressing that vessel, and so disposing to the occurrence of the œdema of the limb. After removal, the tumor was found to consist of a mass of condensed cellulo-adipose tissue, with much vascular structure intermixed, and some small

cysts. The œdema gradually subsided; and when the patient left England, about three months after the operation, the limb had nearly regained its normal size, being but little larger than the sound one.

HEMORRHAGIC DIATHESIS.

In connection with diseases of the arteries, it may be stated that in some constitutions it is found, though fortunately very rarely, that there is a great tendency to very troublesome, indeed almost uncontrollable bleeding, from trivial wounds; life being put in jeopardy, or even lost, by the hemorrhage resulting from the extraction of a tooth, the opening of an abscess, lancing the gums, or some equally slight unimportant surgical procedure. The blood does not flow in a jet, but continues to trickle in an oozing stream, apparently from the capillaries rather than from the arteries of the part. In these cases also there is a great tendency to an inordinate amount of ecchymosis from very slight contusion, the areolar tissue becoming rapidly filled with fluid uncoagulable blood.

Causes.—The *hemorrhagic diathesis* appears to be connected with or dependent upon one of three distinct conditions:—

1. It may be congenital, and not unfrequently is hereditary, especially in the male line. In some families the males only have been affected, and the diathesis has been transmitted in the second or third generations through females; who, themselves being unaffected by it, have had male children who were the subjects of the disease. A very remarkable genealogical account of such a family has been drawn up by C. Heath. This diathesis occurs in persons otherwise robust and strong, without any apparent derangement of health, or morbid condition, innate or acquired, to account for it. In such cases the family peculiarity is usually recognized, and well known to those liable to it.

2. The hemorrhagic diathesis may occur in individuals from some fault in the solid constituents of the body. In persons who are "out of condition," with soft and flabby texture, the tissues have lost their normal contractile power, and are too readily torn by external violence. In such individuals slight blows may be followed by extensive extravasation, and trivial wounds by abundant and continuous hemorrhage. The bleeding in these cases appears to be favored by the laxity of fibre interfering with the proper contractility of the divided vessels.

3. The hemorrhagic diathesis may be dependent upon a morbid state of the blood itself, in consequence of which it has lost its coagulability, the fibrine being insufficient in quantity. This is especially apt to occur as a consequence of diseases that produce a diffluent state of the blood, such as chronic jaundice, albuminuria, scurvy, &c.

The last two conditions are not unfrequently associated together, the bloodvessels being insufficiently contractile, and the blood too poor in fibrine, when excessive hemorrhages are apt to occur from the most trifling wounds. In cases of this kind, care must be taken not to make any surgical wounds if they can possibly be avoided; though it is a remarkable fact that the hemorrhagic tendency here described seems only to have been met with after trivial injuries of the kind above mentioned, and not to have been encountered in any really serious surgical case.[1]

Treatment.—In the constitutional treatment of the diathesis, little can be done. It has been proposed to administer saline hydragogue purgatives, with a view of inspissating the blood. I should, however, imagine that an improvement of the general health, by the administration of iron, and by careful attention to food, exercise, &c., would be the best means of increasing the plasticity of this fluid. In the event of the occurrence of continuous bleeding, the employment of pressure, the application of the actual cautery, or the use of the perchloride of iron, will constitute the best means of arresting the hemorrhage. In some cases the galvanic cautery may be advantageously substituted for the knife, when it is desirable to remove parts in persons who are the subjects of this diathesis. By this means, the smaller amputations, as of the fingers or toes, may be performed, without danger of undue hemorrhage.

[1] [Mr. Durham has reported a case of lithotomy which proved fatal through the hemorrhagic diathesis, which was hereditary in the patient's family. (*Guy's Hosp. Reports*, 3d S., vol. xiii. p. 489.)—A.]

CHAPTER XLII.

DISEASES OF ARTERIES.

ARTERITIS.

THE origin of inflammation of arteries, or *arteritis*, is extremely obscure. In many cases it arises from constitutional causes, with the nature of which we are as yet unacquainted; in the majority of instances, however, it is distinctly of traumatic origin, occasioned by the wound, rupture, or ligature of an artery.

Forms of the Disease.—Arteritis occurs under two distinct forms: as the adhesive or limited, or as the diffuse or erysipelatous. Adhesive arteritis may either be acute or chronic, and may be idiopathic or traumatic in its origin. Diffuse arteritis invariably arises from injury or ligature of the vessel.

Fig. 231.

Plastic deposits in aorta.

Fig. 232.

Plastic plugs occluding the axillary artery and occasioning gangrene of hand and arm.

Adhesive Arteritis.—Both the *coats of the vessel* and the *contained blood* undergo important alterations. In the simplest form, arising for instance from the pressure of a tumor upon an artery, the *coats* are thickened and fused together, as it were, so as to form an impervious cord; in the more acute forms of the disease, the sheath and the external coat become pulpy and vascular, with effusion of plastic matter in and around them. The middle coat does not undergo any primary change, but after a time becomes contracted, thickened, and somewhat softened. The internal coat becomes softened, pulpy, and stained by imbibition of the coloring matter of the blood. In consequence of these changes in the coats, the vessel loses its elasticity and becomes brittle. After the inflammation has existed a short time, a *plug* is deposited in the diseased part of the artery. This plug assumes two distinct forms. It may be deposited as a membranous layer of decolorized fibrine, occluding the orifices of collateral branches (Fig. 231); but most frequently it is deposited in the form of a conical plug, which completely blocks up the vessel at the part inflamed, below which the calibre of the artery is somewhat contracted (Fig. 232). The plug is formed of two distinct materials. The middle and lower parts consist of a mass of a yellowish or reddish color, composed of inflammatory exudation matter, intermingled with fibrine deposited upon it by the circulating blood, and adhering firmly to the contiguous walls of the vessel. The upper portion of the plug is black, and consists of simple coagulum, deposited upon and tailing on to the decolorized mass; it is usually long, narrow, and stringy, and is not adherent to the sides of the vessel. The plug may continue permanently to block up the artery, which gradually contracts upon it so as to be eventually converted into a fibro-cellular cord; or it may be partly absorbed or channelled through the centre; or lastly, it may be entirely removed by absorption, the calibre of the vessel being freely restored. These plugs or *embola* [*thrombi*—A.] may continue attached to the part of the artery in which they have originally formed; or they may be primarily deposited in one of the larger arteries, the aorta, or even the left cavities

of the heart, and thence be washed by the current of the blood into one of the secondary arteries, becoming arrested at some point of bifurcation or narrowing of the vessel, as the termination of the common femoral or popliteal in the lower extremity or the axillary in the upper, and, there blocking up the vessel, occasion sudden gangrene of the limb. If one of these plugs be driven into a visceral artery, structural changes in the part supplied by the vessel will necessarily ensue, and if the organ be one immediately essential to life, as the brain, instantaneous death may be the consequence of this plugging of one of its arteries by a fibrinous mass formed at and carried from a distant part of the arterial system. In some cases, the patient is conscious by his own sensation of the detachment of one of these embola and its deposit elsewhere. A man came under my care for partial gangrene of the foot arising in this way, who stated that, whilst suffering from an attack of inflammation of the lungs, he suddenly felt something give way in his chest, run down the body and thigh, and stop in the ham; the leg immediately became numb and cold, and gangrene speedily set in. (*See* Embolism, p. 464.)

Diffuse Arteritis.—The morbid appearances extend more widely, spreading along the coats of the artery to a considerable extent; there are redness of a deep claret color, injection, and thickening of the coats, a loss of the physiological properties of the vessel, and an absence of all plastic exudation.

Secondary Effects of Arteritis.—These are of great importance.

Arctation, or even *occlusion*, of the interior of the artery not unfrequently occurs, as a consequence of inflammation of the vessel. This usually results from chronic arteritis, often excited by the pressure of a tumor or by some other local irritant. As it is usually a slow process, there is abundant time for the anastomosing circulation to be set up: so that the vitality of the limb or part supplied by the diseased vessel is preserved. The artery that has been so narrowed and closed, ultimately becomes converted into a cellulo-fibrous cord up to the nearest collateral branch, just as if it had been occluded by a ligature.

The plug which renders the vessel impervious by obliterating it, may in some cases give rise to *gangrene* of the parts supplied. This is especially apt to occur if the arteritis be acute, if the patient be aged, or if the plug be so situated as to occlude some of the principal anastomosing branches, so that there may not be time or opportunity for the collateral circulation to establish itself. In other cases, plastic matter may not only be deposited at the part inflamed, but may even be carried lower down than the original seat of disease, and thus accumulate in the terminal branches of the artery. The vessel will thus be obstructed at two points, between which a pervious part will be included. This double occlusion of the vessel, I believe, renders gangrene of the limb inevitable; at least, in all those cases in which I have seen mortification result from arteritis, this condition has existed.

The plastic matter poured out at the inflamed point may in some cases be carried on through the terminal branches of the vessel into the capillaries, and thus, entering the general circulation, may form buff-colored *deposits in various organs*, especially in the spleen. In other cases, again, it may be carried into the veins, giving rise there to *phlebitis* and to other similar conditions.

Symptoms.—The *local symptoms* of arteritis depend not only on the condition of the vessel itself, but on that of the parts which it supplies. There are pain; some tension and stiffness of the affected limb; a good deal of tenderness; and a cord-like feeling along the inflamed vessel, in which also a jerking and forcible pulsation can be felt. The *pain* below the part of the artery that is inflamed, is always very severe, and is distinctly of two kinds—superficial and deep. The *superficial* pain is seated in the skin, which is excessively sensitive to the touch, so that the patient cannot bear the finger to be laid upon it, just as is the case in neuralgia; it is smarting and pricking, and is, I believe, always associated with more or less loss of muscular power. The *deep* pain is burning and lancinating, and not only follows the course of the vessels, but strikes through the limb in different directions. If the inflamed part of the vessel be not completely occluded by the plastic plug deposited in it, the *pulsation* in the arteries of the limb, below the seat of the disease, may continue much as usual; but in the majority of cases the pulsation ceases in all the vessels on the distal side of the inflamed spot, and the limb gradually loses its temperature, becoming of a dark or livid color, and cold; but yet the inordinate sensibility of the surface continues. As the *gangrene* advances, however, this is lost; the parts at the time that they lose their sensibility, assuming the ordinary characters of dry,

shrivelled, or mummified gangrene, until all indications of vitality cease. If, however, the veins be inflamed, as well as the arteries, the dark moist variety of mortification will result. It is in this way that some of the so-called "spontaneous gangrenes" are occasioned (p. 430).

The *spontaneous gangrene* resulting from arteritis may occur in the upper as well as in the lower extremities, and is not unfrequently met with in young people; at least, in most of the cases in which I have seen it, it has occurred in individuals under the age of thirty. When it is the result of pure arteritis, independent of any other structural affection of the coats of the vessel, the gangrene, I believe, most commonly occurs in the upper extremity. Arteritis, however, is by no means necessarily followed by mortification; the liability to the loss of vitality depends on the seat of the inflammation, being greater when it takes place in the neighborhood of the large collateral trunks of the limb, and when it is of an acute character, so that the anastomosing circulation has not time to establish itself. It also occurs more frequently when the arteritis is idiopathic than when it is traumatic; as then a larger extent of vessel is plugged, and there is a greater tendency to the occlusion of the collateral branches, which are necessary to the preservation of the vitality of the limb. The clogging of the terminal branches, by the plastic matter poured out at the seat of inflammation and washed down into the lower part of the limb, is a frequent cause of gangrene.

The *constitutional symptoms*, which in the local limited adhesive arteritis are in the first instance of an inflammatory kind, speedily sink into the ataxic form as gangrene comes on. In the diffuse arteritis, the asthenic fever sets in early, and speedily destroys life.

Treatment.—The treatment of acute arteritis must be conducted on general principles. Leeches should be applied to the part, and perhaps blood taken from the arm; calomel and opium may then be administered: but as a general rule I would prefer the use of those salines, such as nitre and the acetate of potass in large doses, which we know by experience to possess considerable influence in the solution of fibrinous deposits. When gangrene has supervened, we must wait for the line of separation before recourse is had to amputation, as the disease must be looked upon as being of constitutional origin.

STRUCTURAL DISEASES OF ARTERIES.

An artery may be the seat of various *structural lesions*, which play an important part, not only in giving rise to ulterior diseases in the vessel itself, but in disposing to various affections of the organs which it supplies. If we look on an artery as a tube composed of tissues that differ largely in their organization and structure, we must necessarily consider their diseases to be equally varied; and we shall find that, whilst the changes which take place in the external coat, in which the whole of the vital or nutritive activity of the vessel resides, are chiefly conservative, those that have their seat in the internal and middle coats have a destructive tendency. This important difference in the character of the diseases of the coats of the vessel, is dependent on the relative degrees of vascularity and of vitality possessed by these structures. The diseases of the internal coat are the most interesting in a pathological point of view; those of the external coat in a practical one.

The coats of an artery are liable to the following changes: 1. Plastic deposit on and under the lining membrane; 2. Fatty and granular degeneration; and 3. Calcification.

1. **Plastic Deposits** on the free surface are of a fibrino-albuminous character, occurring in the form of rounded, semi-transparent, and glistening masses, usually met with in the aorta or larger arteries around the mouths of their secondary vessels, or of aneurismal sacs—not unfrequently appearing as agglomerated or calcareous spicula, and attaining great thickness. They are almost structureless, gelatinous, sometimes rosy-looking, and cut with a hard, cartilaginous section. The plastic deposits on the attached surface of the lining membrane are opaque, semi-transparent, yellowish-white, elastic but hard masses, composed essentially of plastic matter with some oily globules intermixed.

2. **Fatty and Granular Degenerations.**—These are of the most interesting character, and play an important part in arterial diseases. They occur under the

different forms of *atheroma* and *steatoma*, and are met with either in the arterial coats themselves, or in the plastic deposits which occur upon or underneath them.

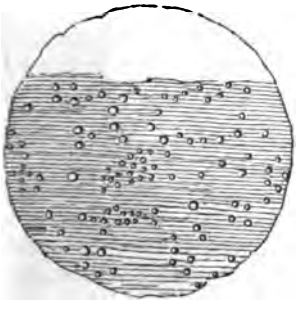
Character.—The atheromatous deposits occur in very different forms, according to their age, &c. Their first appearance is in the shape of fine white opaque streaks, situated in the substance of the lining membrane of the artery. As such, they are most commonly met with in the upper part of the arch of the aorta and in the neighborhood of the orifices of the large arterial trunks; especially along that part of the vessel from which the intercostals arise. Here they may be seen at a very early age. I have met with them in children of three, five, or seven years old. As the disease advances, these streaks aggregate together so as to form a large, white, and opaque patch. The middle coat now becomes thinned by the pressure of the patch, and, from being yellow and elastic, is altered into a gray, semi-transparent, and inelastic membrane, which often becomes stained by imbibition with blood, and presents a condition which corresponds to the "steatomatous deposit" of Scarpa and Hodgson. In the third stage the patch softens, becoming converted into a pultaceous or cheesy mass, and even sometimes undergoing complete liquefaction into a yellow creamy fluid, which has often been mistaken for true pus. These changes will always be found to be dependent on the abundant formation in it of fat-globules and scales of cholesterine. The softened atheromatous patch will be found to be situated in a kind of pouch or depression in the internal or middle coats of the artery, usually of a more or less oval shape.

At the same time when the changes just described are going on in the coats of the vessel, an important alteration is taking place in the connections between the internal and middle coats at the edge of the atheromatous patch: here they become firmly incorporated together, so that the one cannot be peeled away from the other, and the diffusion of the softened atheroma between the two membranes is arrested. Thus also, when the atheroma is washed away by the current of the circulation, the infiltration of the blood between the coats and out of the pouch thus formed in the walls of the artery is prevented.

The changes thus described as taking place in the internal and middle coats of the vessel are destructive, and tend to its rupture; but, coincidently with these, conservative processes take place in the external coat. This becomes thickened, indurated, and strengthened by the deposit of plastic matter, until at last it becomes the sole support of the vessel, around the exterior of which it forms a thick and somewhat rugged wall. It is especially opposite the deeper and more eroded atheromatous patches that this consolidation of the external coat takes place, thus preventing the perforation of the artery in this situation.

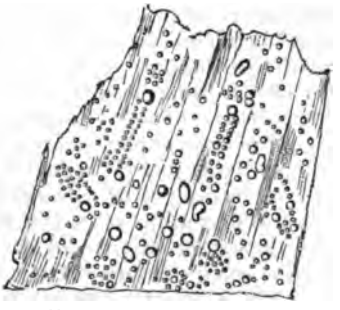
The *nature* and *seat* of these changes will be understood by what has been already stated concerning them. Atheroma essentially consists, as was first pointed out by Gulliver, in a fatty and granular disintegration of the arterial coats; the transformation into fatty and granular matter taking place both in old plastic deposits and in the internal and middle coats of the vessel. The fatty matter consists of oil-globules and cholesterine in various proportions (Figs. 233, 234), the plates of cholesterine

Fig. 233.



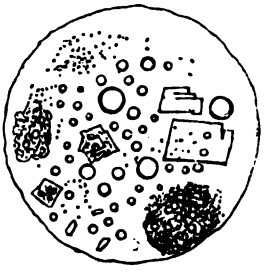
Fatty deposit in internal coat.

Fig. 234.



Early stage of atheroma.

Fig. 235.



Atheroma, with abundant cholesterine.

being largest and most abundant in those cases in which the atheroma is the softest (Fig. 235). This fatty transformation is one to which the fibrous tissues generally are peculiarly subject, and to which those that enter into the formation of an artery

[illegible]

Annular calcification—This is the most frequent, and is principally met with in the larger arteries, such as the aorta, the iliac and the carotids. In this variety, calcareous masses and plates of various sizes, from a grain-like speck to a shell-like plate an inch or more in length, are met with in these vessels. The thickness of the patch varies from that of a sheet of paper to two or three lines. The shape is elliptic or triangular. The greatest diameter may be in the direction of the axis of the vessel. The edge of the plate is ragged, rough and uneven, and the surface smooth and incurvated towards the cavity of the artery. If large it is usually fissured or cracked, and is invariably the seat of more atheroma. These patches are situated in the longitudinal direction of the vessel, and are usually deposited where the structure abounds, as at the arch of the aorta, the bifurcation of the iliacs, and in the carotid arteries. The inner coat is usually thickened and opaque where it covers the patch, and the middle more thinned and wasted.

Fig. 236.

Annular calcification.

Annular calcification principally occurs in arteries of the third magnitude, such as the popliteal and the femoral. It commences by the deposit of granules of calcareous matter (Fig. 236), which are arranged in lines running transversely to the axis of the vessel; these lines gradually increase in breadth until they coalesce laterally, the intervening spaces being filled up, and the vessel being converted into a rigid tube. This form of calcification occurs in the transverse fibres of the middle coat, and is accompanied by but little atheromatous matter.

Fig. 237.

Tubular calcification.

Tubular calcification appears to be an increased degree of the varieties just described, the arteries being converted into pipes or tubes of calcareous matter, with the exception of a few shreds and patches, and some atheroma deposited in the coats (Fig. 237). It is especially the tibial and coronary arteries that are liable to this kind of transformation. When an artery has thus been converted into a tube of calcareous matter, masses of pale, opaque, waxy-looking fibrine are deposited in it, and may block it up more or less completely. These masses not uncommonly undergo subsequent atheromatous degeneration.

The various forms of fatty and calcareous transformation of the arterial coats that have just been described, are constantly found associated together in the vascular

system of the same individual, and often indeed in the same vessel. It has been pointed out by Bizot that the symmetry of the arrangement of these morbid appearances in the corresponding vessels on opposite sides of the body is remarkably great, the arteries of one limb being often the exact counterpart in this respect to those of the other.

Causes.—The frequent coexistence of these various morbid changes in the same portion of the arterial system points to their origin from one common cause, under the influence of which the coats of the vessel may become converted into either fatty or calcareous matter. Indeed, it is quite evident that these are *retrograde metamorphoses*, to which all fibrous tissues are especially liable under the influence of want of proper nutritive activity in the part. And, indeed, any circumstance that induces a deprivation of healthy assimilation in the system generally, will speedily tend to occasion a transformation of the texture of the more lowly organized tissues into products still lower in the scale of organization. Under such influences, the fibrous tissues of which the arterial walls are composed rapidly undergo disintegration, and conversion into fatty, granular, and earthy matter.

That influence under which the vital forces of the system are most commonly diminished in activity is *old age;* and this diminution may be looked upon as natural at any period after the organization has reached its full maturity, whether this be early or late. So frequent, and indeed constant, are these transformations of the arterial coats during the decline of life, that they may be considered as the natural result of the diminution of the nutrient activity consequent upon advance in years. Gmelin has found that there is a progressive increase in the earthy matters contained in the coats of healthy arteries as the individual advánces in life. Thus he has ascertained that the ash of the arteries of a newly-born child yields 0.86 per cent. of phosphate of lime; the healthy arteries of an adult 1.25; and those of an old man 2.77 of the same salt; whilst the ossified arteries of an aged man contain 4.01. There is no precise period of life at which these changes set in: age is a relative term, and, so soon as the system has passed its full maturity, in whatever year of life this may happen, there is a tendency for these deposits to take place in considerable quantity. These senile transformations, therefore, can scarcely be looked upon as pathological changes in many instances. But the same process of degradation of tissue may commence at any, even the earliest periods of life, under the influence of causes that impair the vital forces; and it is in this way that phthisis, granular kidneys, chronic gout, constitutional syphilis, &c., have a direct tendency to occasion these degenerations in the arterial coats. It is a favorite supposition with many pathologists, that these changes result directly from inflammatory action; this certainly does not appear to be the case, but it is by no means improbable that an artery in which the inflammatory process has taken place may thereby have its nutrition so modified as to become more susceptible to early and extensive degeneration, and that the plastic matters thrown out as the result of the inflammation will be especially liable to undergo those changes that ultimately result in their conversion into fat and calcareous matter.

Some arteries are more liable to these structural lesions than others; and the *relative frequency* of the various forms of deposit varies in different arteries. Thus the ascending aorta is most subject to fatty degeneration, whilst the calcareous transformation is most frequently met with in the arch and abdominal portion of the vessel. The arteries of the lower extremities (viz., the femoral, the popliteal, and the tibial) are chiefly affected with calcareous deposits, whilst the fatty are commonly met with in the vessels of the brain; and some arteries appear to be exempt from disease; thus, Tiedemann states that he has never found the œsophageal arteries ossified. The difference in the liability of different arteries to disease is, no doubt, in a great measure to be accounted for by the different degrees of development of the longitudinal fibrous coat in different parts of the arterial system—this being, I believe, in most instances the primary seat of the affection. Thus, in the aorta, the coronary arteries, and those of the brain, in which it abounds, we find these transformations frequent. The distance of the tibials from the centre of circulation, and the consequent diminished nutritive activity of their coats in old people, may account for the frequency of their degenerations. Those points of the arteries, likewise, upon which the shock of the onward wave of blood is most directly received, are more subject to degeneration than neighboring parts of the continuity of the wall of the vessel. This is especially observable at the origins of

the arteries that spring from the arch of the aorta, and at the bifurcation of the iliacs. It is also not improbable that the increased pressure of the blood upon the coats of arteries that lead to diseased organs, through which the circulation is obstructed, may tend to their degeneration.

Sex exercises but little general influence on the liability to disease in the arterial system, though it specially tends to the occurrence of those changes in certain arteries. Thus Bizot states that the arteries of the upper extremity are most frequently diseased in women, and those of the lower in men.

Local Effects.—The structural lesions that have just been described produce certain local effects, often of considerable importance, on the parts which the affected vessels supply with blood. For the proper and healthy nutrition of a limb or part to be carried on, two great conditions are required, so far as its arteries are concerned: 1, that the integrity of the structure of the walls of the vessels continue perfect; and, 2, that their channels remain pervious: for, although the arterial system possesses remarkable conservative power in its arrangement and distribution that tend to counteract these effects, yet, by slow degrees, a deterioration of function and disintegration of structure take place in the part immediately supplied by the diseased vessel. Thus, in the limbs, we have all the signs of a defective circulation —coldness of the feet, cramps, and spasms of the muscles; whilst, in organs, softening of tissue, fatty degeneration, and other evidence of the want of a proper supply of blood leading to impaired nutrition, manifest themselves.

Further Structural Changes in Arteries.—Besides the changes that take place in the parts to which the diseased arteries are distributed, ulterior effects are produced upon the vessels themselves, which may lead to important consequences. These consist in ulceration of the coats of the artery; their spontaneous rupture; contraction or occlusion of the interior of the vessel; and, lastly, its dilatation into some of the various forms of aneurism.

Ulceration of arteries, though frequently spoken of, in reality seldom occurs; the so-called ulceration being in general an erosion occasioned by a patch of softened atheroma and its investing membrane having been carried away by and into the current of blood, which then washes the base of the depression thus produced in the middle coat, but is prevented from extending between the coats by the process of fusion and cohesion which has taken place in them around the patch. This apparent ulcer is deepened by the deposit around its margin of plastic matter, often in large gelatinous-looking masses. When true ulceration of an artery takes place, it is by destructive action from without, and not by any of the disintegrating processes commencing within the vessel.

Spontaneous rupture of an artery is rare, and never happens without disease of its coats. Experiments made by Peacock, which I have repeated, and the accuracy of which I can fully confirm, prove that a healthy artery will sustain a very great pressure from water injected into it, without its walls giving way. But, if these have been softened or weakened by disease, they may be unable to resist even the ordinary impulse of the blood; and if this be driven on by any unusually forcible action of the heart, as under the influence of sudden violent strains or exertions, they may give way. This occurrence would be much more frequent than it is in atheromatous and calcareous patches, were it not for the conservative consolidation of the external coat of the vessel supplying that resistance which has been lost by the destruction of the internal and middle tunics. Hence this rupture is most frequent in those vessels the outer coat of which is thinnest, and in which, consequently, it can least supply the place of the others, as in the arteries of the brain and in the intra-pericardial portion of the aorta.

Contraction and *occlusion* of arteries are by no means rare sequences of the structural lesions of these vessels. We have already seen that these conditions may arise from inflammation of the coats in any way excited, as by the pressure of tumors; but, besides this, the structural changes that take place may produce narrowing and closure of the vessel in various ways. Thus the diseased patch may project into the artery in such a manner that plastic matter and coagulum are gradually deposited upon it, until the interior of the vessel is blocked up; or the irritation of the morbid products may give rise to chronic inflammation in the coats, occasioning contraction, the effusion of lymph, and their consequent occlusion. In one or other of these ways, arteries of all magnitudes may be gradually narrowed and at last completely closed; and yet the patient may survive, and the parts sup-

plied by the obstructed vessel may maintain their vitality, in consequence of the collateral circulation being sufficiently active to keep up the supply of blood to them. The vessels that are most frequently blocked up in this way are the tibials; next to these perhaps the carotids; the other arteries are but rarely so occluded. Yet many instances have been collected by Tiedemann, of this morbid process affecting most vessels, but more especially the iliac, the brachial, and the axillary arteries, and the different branches of the abdominal aorta. Tiedemann records from various sources no fewer than eight cases in which the abdominal aorta was completely closed, in all of which so full and efficient a collateral circulation had been set up, that the vitality of the lower part of the body was perfectly maintained, and in most the morbid state was not suspected during life. Besides these cases, he states that there are twelve instances on record of great narrowing of the aorta, at that point where the ductus arteriosus is implanted into it in fœtal life. These would appear in some way connected with the closure of the duct; as in every case the indentation was greatest on the convex part of the aorta, which had been drawn in towards the mouth of the duct, as if the vital contractile force necessary for the closure of this had extended itself to the aorta, and produced a similar action in it.

When any of the arterial narrowings, or occlusions, occur in a gradual manner in early life, or in a part where the collateral circulation is free, no ill effects result; but in an opposite condition the interference with the circulation leads to the death of the part supplied by the diseased vessel. This is particularly the case in the lower limbs of old people, where the circulation is extremely feeble, both as the effect of age and in consequence of distance from the heart; and it is in this way that the true senile gangrene or mummification of the limb occurs. The symptoms and treatment of this affection have already been adverted to (pp. 431–32); but it may be here stated that, whilst some have considered the gangrene as entirely the result of arteritis, others look upon it as consequent on the occlusion of the vessel from disease of its coats; and each party has laid down principles of treatment in accordance with its view of the pathology of the affection. From what has preceded, it would appear that the arteries of a limb may be occluded, and that, consequently, gangrene may result from either condition. The occlusion from acute arteritis, followed by gangrene, most frequently occurs in the upper extremities, and in young or middle-aged people, and is preceded by local and constitutional symptoms of inflammation; and in the artery presents on examination the true inflammatory plug. The occlusion from calcification and atheroma chiefly occurs in the lower extremities, and in old people: it is preceded by a rigid condition of the vessels—by cold feet, cramps, numbness, and weakness of the legs; and, after removal, the arteries will be found to be converted into rigid unyielding calcareous tubes, with some deposit of atheroma, and with waxy-looking masses of fibrine filling up their interior. Besides these two distinct forms of the disease, there is a third and very common variety, in which a low form of inflammation takes place in previously diseased arteries, and in which we find a combination of the two conditions.

Treatment.—With regard to the treatment of narrowing or occlusion of the arteries, unconnected with gangrene, I have little or nothing to say, except that, if there be reason to suspect such occurrence in a limb, care must be taken to keep the part warm by means of appropriate clothing, and if there be much pain, to allay this with opiates. If gangrene have come on, it must be treated with reference to its cause. That connected with arteritis has already been discussed; but when it occurs from structural disease of the coats of the vessel, then the treatment must be directed by the existence or absence of any complicating inflammation, in accordance with those principles that have been laid down in discussing the general management of gangrene.

CHAPTER XLIII.

ANEURISM.

By *aneurism* is meant a tumor, dependent on the dilatation of the whole or a portion of the coats of an artery by the contained blood, and communicating with the interior of the vessel.

Causes.—The causes of aneurism are divisible into those that predispose to, and those that excite, the disease. Aneurism is *predisposed* to by any affection of the arterial coats that lessens the elastic resiliency of the vessel, and at the same time weakens its resisting power. When the arterial walls have undergone more or less *fatty degeneration*, whether that consist in the distinct deposit of patches of atheroma, or in a sort of molecular deposit of fat-globules in the tissues composing their coats, their natural elasticity and resiliency become lost, proportionately to the amount of fatty change that has taken place within them. Hence, as the artery becomes less and less able to contract on its contents, and to recover during the diastole the tension exercised on its walls during the systolic impulse, it gradually becomes distended by the repetition of the shocks which it sustains, and thus either complete or partial dilatation of its cavity takes place. I believe that this loss of elasticity and of power of contracting on its contents, which eventually results in the dilatation of the vessel, never occurs except as the result of previous disease of the coats. In the very numerous specimens of dilated arteries that I have examined, I have never found one that had not undergone fatty degeneration, or atheromatous deposition. Calcification, on the other hand, rather prevents than favors dilatation of the artery, by hardening the coats and converting them into rigid inelastic tubes; but atheroma softens them, and causes yielding of that portion of the vessel affected by it. I have frequently observed that the whole of the artery might be healthy except at one part, where there was an atheromatous patch, and where the vessel was dilated; or that the whole of its coats might be calcified except at one spot, where atheroma was deposited, and where consequently the coats had yielded under the outward pressure of the contained blood.

Age exercises a powerful predisposing influence on the occurrence of aneurism. This disease is excessively rare before puberty, yet is occasionally met with at early periods of life: thus Syme mentions a case of popliteal aneurism in a boy of seven, and Hodgson has a preparation of a carotid aneurism in a girl of ten. It is during the middle period of life, about the ages of thirty and forty, that aneurisms are most frequently met with; at those ages, indeed, when the arteries have already commenced to lose their elasticity, in consequence of disintegrating changes, whilst, at the same time, the heart has not lost any of its impulsive force, or the general muscular system its contractile vigor; and when the enfeebled and inelastic vessels, becoming exposed to powerful causes of distension, may readily give way and be expanded at some one weakened point.

A *forcible, irregular, and occasionally greatly increased action of the heart* is the immediate cause of the over-distension and dilatation of the vessels, and thus of the production of aneurism. Hence we find that this disease is especially apt to be induced in those individuals in whom the muscular system is called upon to make sudden, violent, and intermittent exertions; as, for instance, in men who habitually lead somewhat sedentary lives, but occasionally and suddenly change their habits, and indulge in sports, such as hunting, rowing, or a long day's shooting, which they might without risk have practised in early life, but which cannot be taken up with impunity at an age when the arteries, having become weakened, are unable to bear the same strain upon their coats as heretofore. I agree with Porter, in thinking that continuous, steady, laborious employments do not predispose to aneurism, as this disease is seldom met with amongst those of the lower classes who labor hard and uninterruptedly; but it rather occurs in those who, after long periods of comparative inaction, are occasionally and suddenly called upon to make very violent

muscular efforts, disproportioned to their strength, or, at all events, to their previous habits. It is in this way that soldiers, sailors, and members of the higher classes in society, are rendered peculiarly liable to aneurism. As violent muscular exertion predisposes to this disease, we should necessarily expect to meet with it more frequently among men than in women; and accordingly, Crisp finds that, of 551 cases of aneurism of all kinds, more than seven-eighths occurred in men. It is important, however, to observe that different kinds of aneurism occur with varying degrees of frequency in the *sexes:* thus, this affection is met with in the carotid artery about as often in women as in men, whilst the other external aneurisms occur in the proportion of thirteen cases in males to every one that happens in a female. It is remarkable, however, that in the dissecting aneurism the proportions are reversed; for every one case in men, two occur in women.

Climate exercises an important influence on the occurrence of aneurism, which is far more frequent in cold than in hot countries. If we may judge of the prevalence of aneurism in a country by the number of published reports of cases, I should say that it is of more common occurrence in Great Britain and Ireland than elsewhere; indeed, Roux states that it is less frequent in France than in England. In America it is also of frequent existence; but in the East Indies it is comparatively rarely met with.

Cachexy induced by any cause, such as syphilis, chronic gout, or rheumatism, the abuse of mercury, &c., has a tendency to occasion disease of the coats of the arteries, and thus to predispose to aneurism. But, though mercury and syphilis are commonly said to tend specially to the production of this disease, I am not aware that we are in possession of any facts that would warrant us in coming to this conclusion; though there can be no doubt that the cachexy thus induced may dispose to it as much as any other cause. It is remarkable that phthisis is antagonistic to aneurism; though probably this may arise from the facts that the heart's action is feeble in that disease, and that violent muscular exertion is seldom undertaken by those laboring under it.

Any *obstacle to the free flow of blood* through an organ or the capillaries of a part, exercises an important influence in disposing to aneurism, as it throws an increase of pressure on the interior of the artery. Chevers believes that obstruction in the abdominal organs frequently occasions aneurisms of the abdominal arteries.

The only *exciting* or *direct occasioning causes* of aneurism are blows, violent strains, and wounds of an artery. When an atheromatous artery is concussed by a *blow*, the lining membrane covering the softened patch may be ruptured, the atheroma being poured out into the interior of the vessel; and thus the external coat, with perhaps a portion of the middle adherent to it, becoming exposed to the pressure of the contained blood before it has been fully consolidated by inflammation and plastic deposit, the foundation of an aneurism may readily be laid. In very violent *muscular strains or efforts*, an artery may occasionally be completely torn across; and it is easy to understand how, under these circumstances, the increased pressure that is thrown upon its interior may give rise to dilatation of an already weakened portion of the vessel. *Wounds* implicating arteries are common causes of those various forms of aneurism that have already been discussed in considering injuries of arteries.

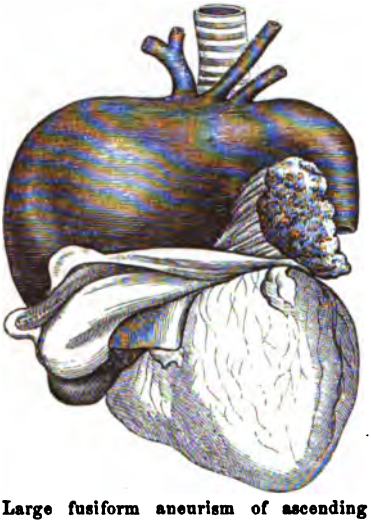
Classification.—Aneurism may be classified as follows:—

1. Fusiform.—True.
2. Sacculated.— { *a.* True. / *b.* False. { α. Circumscribed. / β. Diffused.
3. Dissecting.

1. Fusiform or Tubular Aneurism.—This is a preternatural dilatation of an artery, all the coats of which are equally expanded through the whole circumference of the vessel. It most frequently occurs in the aorta, and may, though rarely, be met with elsewhere. The fusiform aneurism is not a mere dilatation of the vessel, but there are elongation, thickening, and degeneration of its walls as well. The elongation of the artery in the fusiform aneurism is as marked as its dilatation, and is always very considerable. Thus the arch of the aorta may attain a length of several inches, with a considerable space between the origins of the carotids, the innominata, and the subclavian, at the same time that its walls are greatly thickened, nodulated, and rugged. Sometimes several tubular or fusiform aneurisms are

met with in the same vessel, with healthy portions of the artery between them. From these dilatations sacculated aneurisms not uncommonly spring. On examining the structure of a fusiform aneurism, it will be found that it is always composed of an uniform expansion of all the coats of the artery, which are at the same time somewhat altered in character; thus, the outer coat is thickened, the middle rigid and inelastic, and the inner one stiffened, rugged, and tuberculated by the deposition beneath it of various plastic and atheromatous masses. No coagula, however, are found in the dilatation, but a few filamentary shreds of fibrine are occasionally seen to be attached to the inner wall. The arteries that are usually the seats of fusiform aneurism are the arch of the aorta (Fig. 238), the iliacs, and the femorals. This particular form of aneurism occurs most generally in vessels in which the yellow elastic coat is largely developed, and hence is rarely met with in arteries smaller than the femoral: sometimes, however, it occurs in the basilar artery of the brain.

Fig. 238.



Large fusiform aneurism of ascending aorta bursting into pericardium.

The fusiform dilatation, especially when seated in the arch of the aorta, may attain a very considerable magnitude, and may consequently exercise very injurious pressure on contiguous parts, thus producing great distress and danger of life. It is usually extremely chronic, increasing very slowly, and being compatible with existence for many years; but at last it usually destroys the patient, and may occasion death in several ways. Thus, if it be situated in the aorta, the great mass of blood in the sac may, by impeding the circulation, overpower the heart's action, so that it may be unable to recover itself, and a fatal syncope may be induced. Then, again, death may result from pressure on important parts, as on the bronchi or œsophagus. In general, however, the cause of death is the giving way of a sacculated aneurism springing from the fusiform one. When, however, tubular aneurism of the arch of the aorta occupies the intra-pericardial portion of the vessel, it not unfrequently happens that, owing to the absence of an external coat in this situation, the artery may rupture. It most commonly happens that a fusiform aneurism remains quiescent, being a source of discomfort, but not of death, until the sacculated form of the disease spring from its side; and then this, becoming the more formidable affection, may destroy life in some of the ways peculiar to it.

Fig. 239.

Sacculated aneurism of ascending aorta. Death by pressure.

2. **Sacculated Aneurism.**—By the sacculated aneurism is meant a tumor springing from the side of an artery or of a tubular aneurism, with the interior of which it communicates by a narrow aperture, called the mouth of the sac (Fig. 239). It is generally divided into the *true* and *false* varieties.

True Sacculated Aneurism.—By this is meant a partial dilatation of all the coats of the vessel. Its existence has been denied; thus Scarpa doubts the occurrence of such a disease, and Bizot seems disposed to coincide with him. With these eminent pathologists, however, I cannot agree; and though I am willing to admit that many of the so-called "true" aneurisms are not so in reality, yet I cannot doubt, from repeated observation, that Hodgson is right in saying that in their early stages aneurisms are not unfrequently of the true kind. Thus, we occasionally find, as Peacock has pointed out, small digital

pouches springing from the walls of some of the larger arteries, through the whole of which the external, middle, and internal coats can be demonstrated by maceration to exist; and in those aneurisms which are formed by the dilatation of a comparatively large portion of the arterial wall, it not unfrequently happens that the tumor remains of the true kind for some time, as I have had occasion more than once to ascertain by careful dissection. But after an aneurism has attained a certain size, its coats become so fused together, and so closely incorporated with the neighboring tissues, that their precise structure cannot be made out. Indeed, for a sacculated aneurism to be of the *true* kind, I believe that two conditions are necessary: 1, that the tumor itself be small; and 2, that the mouth of the sac be of tolerably large dimensions. Porter says that he has never met with a *true* aneurism larger than a small orange; and, certainly, none of those that I have seen, provided they were of the sacculated kind, have exceeded this size. In true sacculated aneurisms, also, it is necessary that the mouth of the sac, or that portion of it which communicates with the interior of the artery, should be of a good size, and not bear too great a disproportion to the wall of the tumor. I cannot conceive a large sac with a small mouth to be a true aneurism; for, as the mouth of the sac corresponds exactly in size to that portion of the arterial coats which have been originally dilated, it is not easy to understand how a large sac can be expanded out of a small segment of the wall of the artery. At the same time, in all cases of true aneurism, however small they may be, the size of the sac greatly exceeds that of its mouth; and it is therefore clear that there must have been not only expansion, but a degree of hypertrophy and overgrowth of the wall of the vessel, just as in the tubular aneurism.

False sacculated aneurism is that variety of the disease in which the internal, or the internal and middle, coats have been ruptured, and are consequently deficient. This is by far the most frequent form of sacculated aneurism, and is that which is met with of so great a size. In by far the majority of cases, the internal coat and the innermost layers of the middle coat have been destroyed by atheromatous degeneration, leaving an erosion or depression in the interior of the artery, with weakness of the corresponding portion of its wall, which becomes expanded by the outward pressure of the blood. In these cases the sac is principally formed by the expansion of the outer coat, to which some of the layers of the middle may still be adherent; but which is essentially strengthened and thickened by plastic deposits, and by adhesions to neighboring parts, which have become fused into its composition. In these cases there are outgrowth, hypertrophy, and new deposit in and upon the external coat, as is evidenced by its actually becoming thicker, instead of its being thinned, as it would be were it only expanded. The formation of an aneurism by the herniary protrusion of the internal and middle coats through an ulcerated aperture in the external coat has been described: but, though there is a preparation in the Museum of the College of Surgeons that is supposed to illustrate this fact, I doubt the existence of such a form of the disease, and after careful examination think that the preparation in question looks rather like an artificial dissection than a true rupture of this dense and elastic coat.

A false aneurism may always be readily distinguished from a true one, by the greater magnitude that it attains, by the size of the sac being out of all proportion to that of its mouth, and, on a section of this being made, by the middle coat being seen to terminate abruptly in a thick and dense ring, immediately around the mouth and neck of the sac. A false aneurism may either be so from the very first, the internal and middle coats having been destroyed by softening and erosion, and the external expanded and hypertrophied into a sac; or it may originally have been a true aneurism, and have been converted into the false variety of the disease by the giving away of some of its coats.

Surgeons generally recognize two varieties of false aneurisms—the *circumscribed* and the *diffused*. By the *circumscribed false aneurism* is meant that form of the disease in which the blood is still contained within a sac, formed by at least one of the arterial coats, however expanded and altered in its structure this may be. The *diffused* form of *false aneurism* includes two distinct varieties of the disease. In one case there is rupture of the sac, and general and widely spread extravasation of blood into the areolar tissue of the limb or part. In the other case it happens that the sac formed by the dilatation and hypertrophy of the outer coat of the artery is ruptured, and the blood, although effused beyond this, is still confined in a sac of

condensed areolar tissue, formed by the matting together with coagulum and lymph of the structures into which the blood has been effused.

3. **Dissecting Aneurism** is a remarkable form of the disease, originally described by Shekelton, in which the sac is situated in the wall of the artery between its coats. It originates in consequence of the internal coat of the vessel becoming eroded, and giving way before any of that adhesion and matting together of the tissues around the patch has taken place, which prevents the blood from being forced between the different tunics of the artery. The rupture, although originating in the internal coat, always extends between the layers of the middle one, splitting this up into two laminæ, and in some cases it also separates the middle from the external tunic of the vessel. On examining the artery in a case of dissecting aneurism, its coats will always be found to be easily separable from one another, and to be very lacerable, often appearing soft and sodden as if macerated. For the production of this disease, indeed, two conditions are necessary; 1. That there be atheromatous disease of the artery, destroying a portion of the internal and of the innermost layers of the middle coat; and 2. That there be not only a want of plastic matter effused about the diseased part of the vessel, but also a general softening of the tissue of the middle coat, with want of cohesion between the different tunics of the artery: this, indeed, may be considered as the essential condition disposing to the formation of a dissecting aneurism, and causing the disease to assume this rather than the sacculated form.

The rupture constituting dissecting aneurism always takes place longitudinally along the middle coat, and may often extend to a very considerable distance. Thus it may reach from the arch of the aorta to the iliacs, or from the same part to the bifurcation of the carotids. The disease only occurs, however, in the aorta, and in its principal branches—in those arteries, indeed, in which the middle coat is highly developed, and the yellow elastic tissue abundant.

Classes.—Dissecting aneurisms arrange themselves into three distinct classes. 1. In one class, the blood, after having passed for a distance of several inches, or even more, through the substance of the middle coat, bursts through the external coat, and becomes effused into the areolar tissue outside the vessel and around the seat of rupture, or into the neighboring cavities (Fig. 240). In these cases, which constitute the most common variety of the disease, death usually occurs rapidly, the patient feeling intense pain along the line of rupture, and falling into a state of syncope. 2. The external coat may become so thickened and strengthened by the deposit of plastic matter, that it resists the impulse of the blood, which consequently continues to pass between the layers of the middle coat until it meets a softened and atheromatous patch, and then again bursts into the canal of the artery. In this class of cases the patient may live for years after the occurrence of the rupture; the new channel that the blood has taken becoming lined with a dense smooth membrane, and resembling closely the interior of the artery, from which, however, it is separated by a kind of septum or mediastinum. The appearance here presented by the vessel has occasionally been erroneously described as constituting a double aorta. 3. The blood may find its way between the laminæ of the middle coat, but does not escape farther by rupture of the external, or by the giving way of the lining membrane of the vessel. A sac is consequently formed in the substance of the middle coat, which may become chronic, but will at last undergo external rupture.

Fig. 240.

Rupture of lining membrane of aorta, giving rise to a dissecting aneurism, which burst into pericardium. Aorta much dilated, and covered with calcareous plates, except where the aneurism occurred: there it was atheromatous.

Process of Formation of an Aneurism.—The progression of the changes leading to the formation of an aneurism is briefly as follows. The coats of the artery undergo fatty degeneration, and atheroma is deposited at one part; this softens, and the lining membrane covering it, perhaps with a portion of the inner layers of the middle coat, becomes eroded; or the walls of the vessel may be weakened at this point without any destruction of their coats. Cohesion, however, takes place between the tissues of the vessel at the eroded or weakened spot; and the outer coat becomes strengthened and thickened by the deposition of plastic matter. Dilatation next takes place at this point; if of the entire coats, a *true* aneurism is formed; if of the eroded tunics, a *false* aneurism occurs: but if no cohesion have previously taken place between the different coats of the vessel, the blood becomes effused into and between them, thus constituting a *dissecting* aneurism.

Structure of an Aneurism.—An aneurismal sac, if it be composed of a dilatation of all the coats of an artery, may be recognized on dissection by the athero matous and calcareous deposits which are met with in the tissues of which it is composed. If it be a false aneurism, it will be found that there is little if any, of these deposits in the walls of the sac; that the middle coat usually terminates abruptly at its mouth, and that the external coat is greatly thickened and strengthened by the deposition of plastic matters. An aneurismal sac may vary in size, from a tumor not larger than a cherry to a growth of the magnitude of a cocoa-nut or large melon. The mouth, which is oval or round in shape, varies greatly in size, being always very small in proportion to that of the sac. Usually the interior of an aneurismal sac contains a quantity of decolorized fibrine, arranged in concentric laminæ of but moderate thickness; these laminæ of fibrine are of a pale-buff color, dry, and somewhat brittle where they are most closely applied to the wall of the sac; the more external ones appear to be those that are first formed, and occasionally are found to have undergone a kind of atheromatous degeneration; as we approach the interior of the vessel, they become softer and more colored, and at last, in the central portions, dark masses of coagulum are often met with. This decolorized fibrine appears to proceed from two sources. It is partly deposited from the blood which is beaten up in the interior of the sac, and thus deposits its fibrine much in the same way as when it is whipped in an ordinary vessel; this is probably the manner in which the principal masses are deposited, and the fibrine so deposited is arranged in laminæ that take the course of the current of the blood, as in Fig. 241. In some cases, however, it would appear as if it were formed by deposition from the wall of the aneurism; for the mass, not being out of the current of the circulation, cannot well have been deposited from the blood, but must in all probability have been the result of the effusion of plastic matter from the wall of the sac; in these circumstances, there is little if any of that stratified arrangement that is observable in the fibrine which is deposited from the blood. The black coagulum that is occasionally met with in the middle of aneurisms differs in every way from the laminated fibrine just described, and is evidently the result of simple coagulation. The use of the deposited fibrine appears to be in a great measure to strengthen the walls of the sac, and thus to prevent the too rapid increase of the tumor. Another great purpose that it serves is to lessen the capacity of the sac, and thus to diminish the distending force of the blood which is injected at each stroke of the heart—the outward pressure depending as much on the area of the sac as on the force with which the blood is driven into it. Then, again, the lining of the walls of the sac with such a tough and elastic material as the stratified fibrine, must greatly tend to deaden and break the force of the shock of the wave of blood that is projected against what would otherwise be an unprotected and expanded membrane. In those cases in which the laminated fibrine is small in quantity

Fig. 241.

Large aneurism of ascending aorta, projecting against, and protruding outwards, the ribs. Layers of laminated fibrine arranged in the direction of the current of the blood.

are especially liable. All those theories are consequently erroneous which attribute atheroma to previous inflammation, to suppuration, or to a deposit *sui generis* in the artery. The primary seat of the changes is the lining membrane of the vessel, in the outer layer of which, corresponding to Henle's *fenestrated coat*, they are first met with, as I have often observed, after macerating and dissecting diseased arteries.

Effects.—The most important consequence of these changes in the structure of the artery is the effect produced upon its vital properties. Instead of being an elastic resilient tube, reacting on the contained blood and serving to regulate its distribution, it becomes inelastic, and consequently either gradually dilates in its calibre under the influence of the outward pressure of the blood contained within it, forming perhaps an aneurism; or, being incapable of regulating the distribution of the vital fluid, tends to impair the supply to the organs to which it leads, and thus may indirectly occasion softening, disintegration, or mortification.

3. **Calcification** of arteries comes next in order of frequency to their fatty disintegration. This consists in the deposit in their coats of a quantity of hard and gritty earthy and saline matters, which, though commonly called osseous, present none of the true characters of bone—no trace of bone-corpuscle or of vascular canal being ever traceable in them. Microscopical examination shows them to consist of an irregular crystalline granular mass, without any evidence of organization, composed, according to Lassaigne, of 50 parts of animal matter, 47½ of the phosphate, and 2 of the carbonate of lime in every 100. The deposit always takes place in the first instance in minute sabulous grains or granules; these after a time coalesce, assuming different forms according to the seat of the deposit and the age of the individual.

Laminar Deposit.—This is the most frequent, and is principally met with in the larger arteries, such as the aorta, the iliac, and the carotids. In this variety, calcareous masses and plates of various sizes, from a grain-like sand to a shell-like plate an inch in width, are met with in these vessels. The thickness of the patch varies from that of silver paper to two or three lines. The shape is elliptic or triangular, the largest diameter being in the direction of the axis of the vessel. The edge of the plate is ragged, rough, and uneven, and the surface smooth and incurvated towards the cavity of the artery; if large, it is usually fissured or cracked, and surrounded by much atheroma. These patches are situated in the longitudinal fibrous coat, and are chiefly deposited where this structure abounds, as at the arch of the aorta, the bifurcation of the iliacs, and in the carotid arteries. The inner coat is usually thickened and opaque where it covers the patch, and the middle much thinned and wasted.

Fig. 236.

Annular calcification.

Annular calcification principally occurs in arteries of the third magnitude, such as the popliteal and the femoral. It commences by the deposit of granules of calcareous matter (Fig. 236), which are arranged in lines running transversely to the axis of the vessel; these lines gradually increase in breadth until they coalesce laterally, the intervening spaces being filled up, and the vessel being converted into a rigid tube. This form of calcification occurs in the transverse fibres of the middle coat, and is accompanied by but little atheromatous matter.

Fig. 237.

Tubular calcification.

Tubular calcification appears to be an increased degree of the varieties just described, the arteries being converted into pipes or tubes of calcareous matter, with the exception of a few shreds and patches, and some atheroma deposited in the coats (Fig. 237). It is especially the tibial and coronary arteries that are liable to this kind of transformation. When an artery has thus been converted into a tube of calcareous matter, masses of pale, opaque, waxy-looking fibrine are deposited in it, and may block it up more or less completely. These masses not uncommonly undergo subsequent atheromatous degeneration.

The various forms of fatty and calcareous transformation of the arterial coats that have just been described, are constantly found associated together in the vascular

CHAPTER XLIII.

ANEURISM.

By *aneurism* is meant a tumor, dependent on the dilatation of th portion of the coats of an artery by the contained blood, and comm the interior of the vessel.

Causes.—The causes of aneurism are divisible into those that p those that excite, the disease. Aneurism is predisposed to by a arterial coats that lessens the elastic resiliency of the vessel, an weakens its resisting power. When the arterial walls have un *fatty degeneration*, whether that consist in the distinct deposit or in a sort of molecular deposit of fat-globules in the tissue their natural elasticity and resiliency become lost, proporti fatty change that has taken place within them. Hence, e and less able to contract on its contents, and to rec tension exercised on its walls during the systolic impul tended by the repetition of the shocks which it susta or partial dilatation of its cavity takes place. I be and of power of contracting on its contents, which tion of the vessel, never occurs except as the resu In the very numerous specimens of dilated arte never found one that had not undergone fatty d tion. Calcification, on the other hand, rather artery, by hardening the coats and convertin atheroma softens them, and causes yielding it. I have frequently observed that the wh at one part, where there was an atheromat or that the whole of its coats might be was deposited, and where consequentl pressure of the contained blood.

Age exercises a powerful predisp This disease is excessively rare bef periods of life: thus Syme menti and Hodgson has a preparation the middle period of life, abou most frequently met with; a commenced to lose their elas at the same time, the heart muscular system its contr becoming exposed to p expanded at some one

A forcible, irregula immediate cause of th production of aneu induced in those in sudden, violent, a lead somewhat and indulge in might witho impunity at the same s that conti this dise and un parati

or altogether deficient, the aneurismal tumor rapidly increases with a forcible pulsation that is not met with in other circumstances.

Pressure Effects.—As the sac of an aneurism enlarges, it exercises injurious and often fatal effects by its pressure upon contiguous parts. These pressure-effects deserve attentive consideration and study, as they constitute an important and, in some instances, the sole element in the diagnosis of the existence of aneurism.

One of the most common pressure-effects of aneurism is the occurrence of œdema of the limb or part, owing to the compression exercised by the tumor upon the large and deep *venous trunks* in its vicinity. The consequent obstruction to the venous circulation in the interior of the limb may also give rise to a distended or varicose condition of the subcutaneous vessels, and in some instances it may even go on to the production of gangrene. The pressure of the sac, also, on neighboring *arteries*, or even on the upper part of the very vessel from which it springs, and its interference with the general capillary circulation of a part, is commonly associated with the venous compression, and may considerably increase the ill consequences resulting from it. The pressure upon a neighboring artery may go on to perforation of the vessel by the sac, and so a communication between the two may be set up; thus aneurism of the aorta has been known to perforate and communicate with the pulmonary artery. By its pressure upon neighboring *nerves*, an aneurismal sac may give rise either to great pain in the parts supplied by them, or to disturbance of their function; the nerves themselves becoming, in some cases, expanded or flattened out, and ribbon-like (Fig. 242), and in other instances tortuous and waving, and being considerably elongated. The pain in the nerves is often one of the earliest signs of the existence of an aneurism. The pain is usually of two kinds: it is either lancinating and radiating along the course of the nerve that is compressed; or, when the tumor presses severely upon neighboring parts and tissues, more especially if it give rise to erosion of the bones (as in Fig. 257), an aching, burning, tearing, or boring sensation is often experienced in the part subjected to the pressure. In other cases, again, important modifications in the function of parts take place, in consequence of the pressure that is exercised upon their nerves. Thus, for instance, the compression of the recurrent laryngeal will occasion hoarseness of voice and difficulty of breathing, depending on spasm of the glottis. On the *bones* an aneurism may produce very important effects by its pressure, eroding or wasting away the osseous tissue in some instances, and in others giving rise to true caries. If the bone be a flat one, as the sternum, the aneurism may perforate it by making as smooth and round a hole in it as if this had been worked by the trephine. *Glandular organs and their ducts* in the neighborhood of aneurisms suffer the most injurious effects from the pressure of these tumors, their functions being arrested, and the passage of their secretions interfered with; so also, by the pressure exercised on the *trachea* and *œsophagus*, respiration and deglutition may be seriously impeded.

Fig. 242.

Flattening of posterior tibial nerve by pressure of an aneurism of the calf.

Number.—Aneurisms, though usually single, are not very unfrequently multiple. There may be more than one tumor of this kind in the same limb; thus the iliac and femoral arteries on the same side may both be affected. In other cases, corresponding arteries in opposite limbs are the seat of aneurism; thus, the two popliteals are not unfrequently found to be the seat of this disease, and occasionally an aneurism may exist in one of the limbs, and others in the arteries of the interior of the body. When more than one aneurismal tumor occurs in the same individual, the patient is said to be laboring under the *aneurismal diathesis*. Numerous aneurismal tumors are at times met with in the same person; thus, Pelletan records a case in which no fewer than sixty-five were observed.

Duration.—The duration of an aneurism varies very greatly. In young full-blooded persons it often makes progress with great rapidity; whereas in elderly people of feeble constitutions, or in those of a cachectic habit of body, accompanied with more or less debility of the heart's action, the disease may assume a very chronic form; thus, Hodgson relates the case of an aneurism of the femoral artery

of twenty years' duration. Much also will depend on the situation of the aneurism, the size of the mouth of the sac, and the relation of the sac to the impulse of the blood into it; the larger and more direct the mouth of the tumor, the more readily will the blood be projected into it at each impulse of the heart, and the more quickly will the tumor expand.

Symptoms.—The symptoms of an aneurism are of two kinds: 1. Those that are peculiar to this disease; and 2. Those that are simply dependent on the presence of the tumor occasioned by the enlarged sac. The peculiar or pathognomonic signs are those that are dependent on the communication of the sac with the artery; they consist of signs afforded by the manual and auscultatory examination of the tumor; those that are dependent on the mere size of the growth are the pressure-effects. It is of course only in external aneurisms that those signs which are ascertainable on manual examination of the tumor can usually be recognized. In internal aneurisms, in the majority of cases, the auscultatory signs and the pressure-effects afford the best indications of the presence and nature of the tumor; though, when this approaches the surface, much information can be gained by palpation.

Symptoms of external circumscribed aneurism.—The tumor is usually round or oval, distinctly circumscribed, and is situated upon and in close connection with some large artery. It is at first somewhat compressible, but afterwards becomes more and more solid as fibrine is deposited in it. The most marked sign is, perhaps, the *pulsation* that is felt in it from the very first. This is of a distensile, excentric, and expanding character, separating the hands when laid upon each side of the tumor, by a distinct impulse from within outwards. The pulsation is more forcible in aneurisms in which there is but little laminated fibrine; and as this increases in quantity it gradually loses its hard expanding character, being converted into a dead *thud*, and in some cases ceasing entirely. When pulsation is obscure, the compression of the artery below the sac will cause it to become more distinct, or it may be increased in force by elevating the limb or part affected. When the artery above the sac is compressed, the flow of blood into the tumor is necessarily arrested, and a considerable quantity of its more fluid contents may be squeezed out by gentle pressure. If the hands be then laid upon each side of the tumor, and the pressure suddenly taken off the artery, the blood will be found to rush into and distend the sac by a sudden stroke, separating the hands from one another. This may be looked upon as one of the most characteristic signs of aneurism.

The *bruit* or *sound* emitted by the blood in its passage through an aneurismal sac was first noticed by Ambrose Paré. It varies much in character, being usually loudly rasping or sawing—loudest and roughest in tubular aneurisms. In many cases it is altogether absent; this especially happens in sacculated aneurisms with small mouths, or in those that are much distended with coagula and blood. The absence of sound, therefore, in a tumor must not be taken as an indication of its not being an aneurism. The sound is usually best heard in tumors that are not too fully distended with blood; indeed, it is usually most distinct when the sac is partially emptied. Thus, for instance, it not unfrequently happens that, in an aneurism of the ham or thigh no bruit, or but a very faint one, is perceptible so long as the patient is standing; but if he lie down, and elevate the limb so as to partly empty the sac, then it is very distinctly audible. Another sign of considerable importance consists in the *diminution in the size* of the tumor, and the *cessation of the pulsation and bruit* in it, that occurs on *compressing the vessel* leading to the sac, and the immediate and sudden return of these signs on removing the pressure from the artery.

All the symptoms that have just been described are peculiar to and characteristic of aneurism, being dependent on the communication that exists between the artery and the sac. Those that result from the pressure of the sac upon neighboring parts are common to aneurism and to any other kind of tumor; but, though not of so special a character as those that have just been described, they are of considerable importance in determining the nature of the disease when taken in conjunction with the other symptoms.

Symptoms of diffused aneurism.—When a sacculated circumscribed aneurism becomes diffused, the sac having given way, but the blood being still bounded by the tissues of the limb, the patient experiences a sudden and acute pain in the part, and usually becomes pale, cold, and faint. On examination, it will be found that

the tumor has suddenly and greatly increased in size, at the same time the [illegible] and its circumscribed and distinct outline. The pulsation and other [illegible] usual; diminished in force and in distinctness, having ceased in [illegible] surface, and may disappear altogether. The limb may also become [illegible] may suffer in other ways from the diffused effects of the pressure of the [illegible] bearing upon the neighbouring veins and tissues. At the same time, the current is being greatly obstructed, the limb may become cool and [illegible] of weight and general inability will be experienced in it. In these circumstances the aneurismal swelling usually becomes harder, in consequence of the coagula of the blood in the serous tissue around the sac, by which indeed the limit of extravasation is marked, and a local boundary is often formed to a limit the extravasated blood. If it be left to itself the tumor will now [illegible] rapidly increase in size, sometimes without sometimes with much pain, — perhaps evidence of inflammatory action around it, so that at last it may [illegible] the circulation through the limb as to occasion gangrene; or, if it advance [illegible] the surface, the skin covering it becomes thinned and reddened, the tumor becomes soft and semi-fluctuating, owing to the coagulum breaking down, and [illegible] external rupture of the sac will ensue.

In some cases it happens that, when rupture of the sac takes place, the effused blood, instead of being limited by the surrounding areolar tissue, becomes diffused and widely extravasated into the substance of the limb. When this unfortunate occurs, the shock and pain [illegible] are very great, and the patient is usually seized with a very severe lacerating and burning pain in the limb. The pain is most severe in those cases in which the rupture takes place under deep fascia, by which the effused blood is tightly bound down; and it may be so severe as to occasion syncope. In other instances, faintness occurs from the sudden loss of blood out of the current of the circulation into the substance of the limb, the swelling being greatest in those instances in which the blood is suddenly and largely effused into the areolar tissue. If the extravasation happen in a limb, the limb will become greatly swollen, hard, brawny, and cold. The superficial veins are distended, and the circulation in the lower parts of the member is soon completely arrested by the pressure of the extravasated and semi-coagulated blood upon the vessels, more particularly the large venous trunks. In consequence of this, gangrene of a moist kind usually makes its appearance, and speedily destroys the patient's life.

Diagnosis.—The diagnosis of aneurism may in many cases be effected with the greatest possible ease by a student in surgery; in other instances it requires a vast amount of care, and the most experienced judgment, to come to a correct conclusion as to the nature of the tumor. This is easily done when the aneurism is superficial, recent, and circumscribed, the blood in it being fluid, and all the signs of the disease well marked. The diagnosis is often replete with difficulty when the aneurism is deeply seated, or, if external, when it is old and filled with coagula; also if suppurative action have taken place about it, or if it have become diffused.

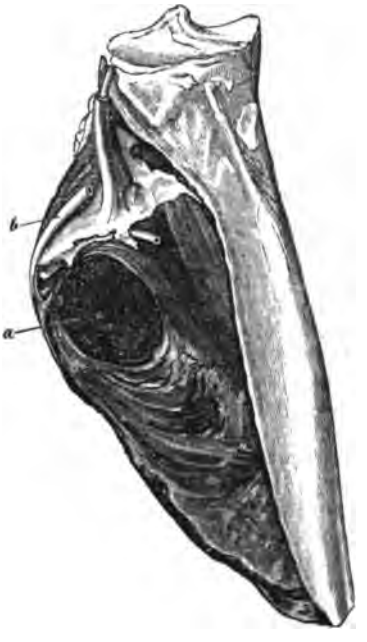
In effecting the diagnosis of aneurism we have, in the first place, to ascertain the existence or absence of a tumor; and, after this has been done, to ascertain whether it be aneurismal or of some other character. Both points, the latter especially, are difficult to determine in internal aneurisms; in the external, the doubt is not as to the presence of a tumor, but as to its nature. The *tumors* with which aneurisms may be confounded may conveniently be divided into two classes—those that do and those that do not pulsate.

Every pulsating tumor is not an aneurism. Thus there may be pulsation in various kinds of *encephaloid tumor*, or in *growths composed of erectile tissue.* In such cases as these, many of the signs of aneurism are present; thus the size of the tumor may be diminished by compression, and the distinct influx of blood into it may be felt on the removal of the pressure, the tumor returning to its original size with a soft swelling pulsation; there may also be a bruit, often of a loud and distinct character. But these tumors may generally be distinguished from aneurisms in not being quite so distinctly circumscribed—in being soft, spongy, and elastic, without the sensation of fluid that is met with in some forms of aneurism, or of solid coagula that occurs in others. Again, the bruit is either of a soft, blowing, and more prolonged character, or else sharp and superficial; the pulsation, also, is not so distinct, and is more of the nature of a general swelling and heaving of the

tumor than of a distinct thump. Much light is also occasionally thrown upon these affections by their being met with in situations where aneurism cannot occur from the absence of any arteries of sufficient size to give rise to it, as, for instance, on the head of the tibia or the side of the pelvis; but if a tumor of this kind be situated upon or under a large artery in the usual site of an aneurism, then the diagnosis is certainly replete with difficulty, and cannot indeed in many cases be made. Several instances have of late years occurred, in which surgeons of the greatest skill and experience (as Guthrie and Stanley) have ligatured arteries on the supposition that they had to do with aneurism, when in reality it was one of the pulsating tumors just described that closely simulated it.

Pulsation may be communicated to a *tumor of a fluid character* seated upon an artery; here the diagnosis, though often difficult, is more readily made than in the last case. Attention to the history of the case, to the impossibility of diminishing the tumor by pressure, either directly upon it or on the artery leading to it, its fluctuation, and want of circumscription, will usually point out its nature. Especial attention should likewise be paid to the facts that the pulsation is a distinct heaving up and down of the tumor, and neither excentric nor distensile, and that the swelling may often be wholly or partly separated, by raising it up from the artery lying beneath it. By attention to these points, abscesses in the axilla, under the pectorals, at the root of the neck, and in other situations where pulsation may readily be communicated to the fluid mass, can be distinguished from aneurism; yet errors in diagnosis have happened, and will continue to do so, from the intrinsic difficulty of these cases, and from no want of skill or care on the part of the surgeon; and those will be most charitable in their criticisms on the mistakes of others, who have most frequently had occasion to experience these difficulties in their own practice.

Fig. 243.



Section of aneurism of calf undergoing spontaneous cure, mistaken for tumor. Limb amputated. (*a*) Black recent coagulum lying in centre of laminated fibrine. (*b*) Posterior tibial nerve stretched.

Tumors that do not pulsate, either by their own vessels or by those that lie beneath them, are not so readily confounded with aneurism as the class of affections that has just been described. Yet it must be borne in mind, that in some instances even aneurisms do not pulsate, or but very indistinctly so, having become filled with a dense and firm coagulum. The non-pulsating tumors that chiefly require attention are *glandular*, *scirrhous*, or *ganglionic swellings*, seated over the carotid artery, at the root of the neck, or in the popliteal space. If these be of a fluid character, their fluctuation, unvarying size, and the want of pulsation in them, sufficiently indicate that they are not connected with the artery, from which they may also frequently be separated, and upon which they may be distinctly moved. If solid, they are usually irregular and nodulated on the surface, and can frequently be detached by the fingers being passed underneath them and raising them from the subjacent vessel. I believe there is more danger of mistaking a consolidated aneurism which is undergoing or has undergone spontaneous cure, and in which there is consequently no pulsation, for a solid (perhaps a malignant) tumor of some kind, than the reverse. I have known one instance in which the thigh was amputated for a very painful solid tumor of the popliteal space, which proved on dissection to be a consolidated aneurism pressing upon the posterior tibial nerve (Fig. 243).

Aneurisms, more particularly those that are diffused, have not unfrequently been mistaken for *abscesses;* and it is no very uncommon thing for a surgeon to be called to an aneurism which, under this supposition, has been diligently poulticed, or painted with iodine ointment. Occasionally, the more fatal error has been committed of puncturing the tumor with the view of letting out pus, when none appears,

and, either immediately or after a lapse of a few hours, profuse arterial hemorrhage ensues. That this accident may arise from the intrinsic difficulties of the diagnosis, is evident from the fact that it has happened to such surgeons as Desault, Pelletan, Dupuytren, Pirogoff, and others of less note. I have once actually seen this accident occur to a surgeon of considerable experience, who, mistaking a diffused popliteal aneurism for an abscess, opened it with a bistoury, but finding no pus, applied a poultice; alarming hemorrhage ensued in about forty hours, and I amputated the thigh on the second day after this untoward occurrence.

The difficulty in diagnosis is especially apt to occur in those aneurisms which, having become diffused, have ceased to pulsate, have no bruit, are elastic, softened, and diffluent to the feel, and in which the skin has become reddened and inflamed by pressure from within. It is only by careful attention to the history of the case, and by skilful manipulation, that the true nature of the tumor can be made out. But an aneurism may actually become associated with an abscess in one of two ways. Thus it may suppurate, inflammation of a suppurative character taking place in the areolar tissue around it, with swelling, redness, œdema, and heat of the integumental structures, increase of size in the tumor, and probably diffuse solidification of it. If this abscess be opened or allowed to burst, dark grumous pus will escape, followed by coagula and masses of broken-down decolorized fibrine, and sometimes accompanied, but more usually followed after a lapse of some hours, by a free and perhaps fatal discharge of florid blood.

Another form of combination between abscess and aneurism consists in the opening of an artery by ulceration into the cavity of an abscess, so that the blood is projected directly into this from the opened vessel. In cases of this kind—of which the instance that occurred to Liston is a good example—we have the ordinary signs of abscess, usually of a chronic character, to which those of an aneurism are generally suddenly superadded, with great increase in the bulk of the tumor. This accident has chiefly been observed in abscess of the neck, opening up a communication with the carotid artery.

With *rheumatism* and *neuralgia* it would at first appear to be difficult to confound an aneurism, but in practice it is not so. I have known several cases in which the lancinating pains of aneurism, more especially when the tumor was internal, have been mistaken and treated for rheumatic or neuralgic affections; and I have even known the pain occasioned by the presence of a large aneurism of the thigh treated for several weeks as rheumatism. In such cases as these, it is of course obvious that a little care and proper examination will usually serve to establish the diagnosis. The aneurismal may be distinguished from the rheumatic pain by its having a two-fold character—being both lancinating and intermittent, as well as continuous, aching, and burning. When this kind of pain is persistent, especially about the back, the side of the head and neck, or arm, it ought always to cause the surgeon's attention to be directed to the condition of the neighboring large vessels.

Terminations.—*Spontaneous cure* of an aneurism is of very rare occurrence. The manner in which it happens has been especially and ably studied by Hodgson, and more recently by Bellingham; and the pathology of this process is of considerable interest, from its bearing upon the cure of the disease by surgical operation. The spontaneous cure may accidentally, though very rarely, occur by inflammation of the aneurism and consequent obliteration of the artery; but most frequently it is by the gradual deposition of laminated fibrine in the interior of the sac that it is filled up completely. This process can only take place in arteries of the second or third magnitude, and never in aneurisms of the aorta; and it can only happen in the sacculated aneurisms, the fusiform not admitting of it, it being necessary that the blood flowing through the sac be somewhat retarded in its passage, so as to give time for the deposit of its fibrine upon the interior of the tumor. This process which is a very different one from the coagulation of the blood, is the increase of a natural condition always going on in the sac. In all cases of sacculated aneurism, there is a tendency to the production of a spontaneous cure, though this is so rarely accomplished. The tendency to it takes place by a contraction and partial occlusion of the artery *below* the sac, and the consequent diminished force of the circulation through it, by which the deposition of fibrine is greatly increased, at the same time that the collateral vessels given off *above* the sac often enlarge to a considerable extent, and thus divert from it blood which would otherwise have passed through it. This condition of the vessel below the sac may be looked upon as

the first and most important step towards the consolidation of the tumor. The process is also materially assisted by the mouth of the sac being small, and so situated that the blood cannot be directly driven into it.

For spontaneous cure to take place, however, it is necessary that the current of blood should continue to circulate through the sac. If it be suddenly arrested, coagulation of the blood which happens to be in the sac may there take place, filling it with a large dark soft clot; the sudden formation of which is, indeed, like a foreign body, apt to induce suppuration and sloughing of the sac and neighboring tissues, and hence is rather prejudicial than otherwise. But, though the blood continue to circulate through the sac, the deposit of fibrine will not take place unless the impetus with which that fluid is sent into and through the tumor be considerably diminished. This may happen from the occurrence, in the distal portion of the artery or the mouth of the sac, of some or other of those conditions that have already been described. So, also, it has been found that, in those cases in which two aneurisms are situated upon one artery, the second or distal one is very apt to undergo partial or even complete consolidation, the blood losing its impetus in its passage through the first sac. Any constitutional cause or condition also, by which the impulse of the heart is lessened, and the force of the flow of blood through the sac diminished (as the occurrence of phthisis), will favor greatly the deposit of laminated fibrine and the consolidation of the tumor.

As the aneurism undergoes spontaneous cure, the pulsation in it gradually becomes more and more feeble, until it ceases entirely; the bruit proportionately lessens, the tumor becomes harder, and at last completely consolidated; at the same time, the anastomosing circulation is sometimes found to be established in some of the collateral vessels of the limb. Eventually, the solidified tumor shrinks in size, undergoing a species of drying and absorption, with ultimate conversion into a small mass of fibro-areolar tissue.

Causes of death from aneurism.—An aneurism may prove fatal in various ways. It does so when internal, most frequently by *pressure* on parts of importance in its vicinity, the patient being destroyed by the exhaustion induced by interference with their functions; this is usually the way in which aneurisms of the aorta occasion death. Then, again, death may result by the occurrence of *syncope*, more especially if the aneurism be of large size, and situated near the root of the aorta. External aneurism most commonly proves fatal by *rupture of the sac;* this may either take place into the interior of a limb, giving rise to one or other of the diffused forms of aneurism, and terminate fatally by the induction of syncope or gangrene; or an aneurism may kill by rupture occurring externally, on one of the surfaces of the body.

Suppuration with *sloughing* of an aneurismal sac is not of very frequent occurrence, but is especially apt to happen in those cases in which the tumor has increased rapidly, or has suddenly become diffused, with much heat and tension of neighboring parts. It is peculiarly likely to happen in tumors of a large size that have become partly diffused, that are filled with masses of decolorized fibrine, and that are situated in places where the areolar tissue is abundant and lax, as in the axilla. The symptoms of this condition impending are swelling, tension with heat, throbbing, and redness of the parts around the tumor; the integuments covering which pit on pressure, and are evidently deeply inflamed, at the same time that there is a good deal of fever and general constitutional irritation. As the suppuration advances, the ordinary signs of congestive abscess occur: the skin covering the tumor becomes red and livid at one part, where pointing takes place; and if the surgeon make an incision into it, or if the tumor burst (as assuredly it will if left to itself), a quantity of sanious pus mixed with large masses of broken-down coagula and fibrine will be let out. The discharge of the contents of the aneurismal sac, disintegrated by and mixed up with the results of suppurative action, may be followed by so profuse a gush of arterial blood that the patient is suddenly exhausted.

The rupture of an aneurism is not always immediately fatal, the aperture in the sac being plugged up by a mass of coagulum, as happened in case Fig. 244; on the gradual detachment of the deeper portions of which the bleeding may recur in small quantities at intervals, and more or less speedily carry off the patient. On the mucous surfaces, as of the œsophagus and trachea, rupture occurs in a similar manner (Fig. 244). On the serous surfaces, as into the pleura or pericardium, the

aneurism may burst by a fissure or stellate opening (Fig. 245) forming in the membrane. An aneurism has been known to give way and discharge blood for some weeks before it proved fatal; and it may even happen that, after the rupture has occurred, no hemorrhage may take place, but death may result from the pressure of

Fig. 244.

Aperture in œsophagus produced by pressure of an aortic aneurism.

Fig. 245.

Stellate rupture of an aortic aneurism into pericardium.

the tumor. Thus, in the case of the late Mr. Liston, the sac of the aneurism which caused the death of that great surgeon had actually given way, a mass of coagulum projecting from it into the trachea; yet death resulted from the irritation induced by pressure upon the inferior laryngeal nerve, and not from hemorrhage.

Treatment.—The treatment of aneurism is of two kinds—constitutional and local. In many cases, as in the various forms of internal aneurism, for instance, the constitutional treatment can alone be employed; and in all cases of external aneurism it should be had recourse to as an important adjunct to any local measures that are adopted.

In the *constitutional* or *medical treatment* of aneurism, the great object is to bring about the same condition as that by which the spontaneous cure of the disease is effected, and, indeed, to put the patient and the part in the most favorable state for nature to consolidate the tumor; and, though it may not be possible in the great majority of cases to effect a cure in this way, at all events the disease may be palliated, and its progress retarded. The sacculated is, however, the only form of aneurism that can ever be cured by constitutional means; in the fusiform variety, all that can be done is to retard the progress of the disease.

The principal objects to be held in view are, in the first place, to lessen the force of the heart's impulse, so as to diminish the excentric pressure upon the arterial coats; and, secondly, so to modify the condition of the blood as to dispose it to the deposition of its fibrine. In carrying out these indications, it should be borne in mind that there are two opposite conditions of the system in which aneurism occurs; in one there is a plethoric, and in the other an anæmic tendency. The plethoric and irritable state of system chiefly occurs in young subjects, in whom the progress of the disease is acute and rapid, attended by much impulse and excitability of the heart, and throbbing of the arteries generally. The other condition of the system principally occurs in elderly people, in whom there is a feeble pulse, a quiet heart, a cachectic state of health, and a tendency to anæmia; in such a habit of body the disease makes slow progress. In these opposite directions it is perfectly clear that the same plan of treatment cannot succeed; and that the constitutional means must accordingly be modified according to the state in which the patient is.

In the acute or hyperæmic state, the plan of treatment originally introduced by Valsalva, and hence called by his name, by which plethora is removed, the irritability of the heart and the force of its action lessened, and the blood brought into a healthy condition, may be advantageously employed, in the modified manner that has been recommended and adopted by some modern surgeons. Pelletan and Hodgson especially report very favorably of this treatment, and I have seen several

instances in which it has proved decidedly beneficial. As recommended by Valsalva, this method of treatment was intended to carry out two important points: 1, by a process of gradual starvation and depletion to reduce the quantity of blood in the system, the power of the heart's action, and consequently the pressure exercised upon the walls of the aneurism; and, 2, after the patient had in this way been reduced, the plasticity of the blood was to be improved by feeding him up in a gradual and careful manner, so that the tendency to the deposit of laminated fibrine might be increased. Valsalva endeavored to carry out the first of these objects by subjecting the patient to small and repeated bleedings, and by gradually reducing the quantity of food that was daily taken, until it was lowered to half a pound of pudding in the morning, and a quarter of a pound in the evening. In this way the patient's strength was reduced until he could scarcely be raised up in bed without fainting; the quantity of food was then gradually augmented, so that the plasticity of the blood might be restored. It is seldom that surgeons carry out Valsalva's plan of treatment in the precise manner indicated by him; it is most commonly found to be more convenient to modify it somewhat according to the circumstances of the case, though the principles on which it is conducted are essentially the same.

In adopting any constitutional treatment in cases of aneurism, the first and most essential point to be attended to is, to keep the patient perfectly quiet in bed and free from all mental, emotional, or conversational excitement. The diet should at the same time be very carefully regulated, being gradually reduced in quantity, and being made to consist principally of farinaceous food, with but a very small quantity of meat, but little liquid, and a total absence of all stimulants. Perhaps the best regimen is that recommended by Bellingham, consisting of two ounces of bread and butter for breakfast, two ounces of bread and the same quantity of meat for dinner, and two ounces of bread for supper, with about two ounces of milk or water with each meal or occasionally sipped in small quantities. At the same time purgatives should be administered, especially such as give rise to watery stools, and remove obstructions of the portal and renal systems; with this view a scruple of the compound jalap powder may be given twice a week. In some cases, if the heart's action be particularly strong, recourse may advantageously be had to small bleedings from time to time. [It is rational to suppose that the internal use of the veratrum viride would be of service in these cases; I have heard of one instance where a very rapid cure was said to have been obtained through the agency of this drug.[1] —A.] Iodide of potassium, in doses varying from 5 to 30 grains three times a day, has been given in several cases of intra-thoracic and abdominal aneurism; and its use has been followed by good results. According to G. W. Balfour, of Edinburgh, of 15 cases thus treated, the suffering of the patient was relieved in all but one; in 12 there was diminution of the size of the sac, and in several of these the cure has been apparently perfect. The enforcement of the recumbent posture in these cases no doubt was of material advantage; nevertheless, there appears to be sufficient evidence to warrant a trial of the iodide as an adjunct in the constitutional treatment of aneurism.

By judiciously carrying out this plan of treatment and modifying it according to the circumstances of the case, consolidation of the aneurismal tumor may occasionally be produced; or, if this be not attained, the progress of the disease will be very materially retarded.

When aneurism, however, occurs in old, feeble, cachectic, or anæmic persons, a lowering plan of treatment is altogether inadmissible: here, the blood being deficient in fibrine, and the system in an irritable state from debility, the best results follow such a course as will improve the plasticity of the blood, and regulate the action of the heart. With this view, complete rest, the administration of the preparations of iron, a dry but nourishing meat diet, and the occasional employment of opiates to relieve pain and to quiet the system, will be attended by the best results. In aneurism occurring in elderly people, and amongst the poorer classes, this plan is perhaps more successful than any other.

In the *local treatment* of aneurism but little can be done with the view of checking its progress, except by the employment of direct surgical means. The application of ice to the surface of the tumor is said to have acted beneficially in some cases; but it is a painful remedy, and may occasionally be attended by sloughing

[1] [See also the report of a case under Dr. Murchison's care in the Middlesex Hospital (*Lancet*, March 27, 1869).—A.]

of the skin to which it is applied. When the pain attending the increase of the tumor is considerable, much relief may be obtained from the application of belladonna plasters, or the use of an embrocation composed of equal parts of oil and of the strong tincture of aconite. These means comprise the only local measures that can be adopted in those cases of internal aneurism, which are beyond the reach of surgical interference.

SURGICAL TREATMENT OF ANEURISM.

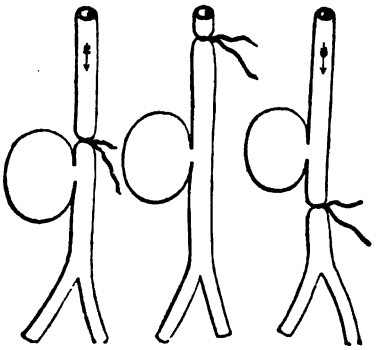
In all those cases in which it is possible to delay with safety, no surgical proceeding should be undertaken for the cure of aneurism until the patient has been subjected to proper constitutional treatment for some time; the success of the more direct surgical means depending greatly, in the hyperæmic forms of aneurism, on the heart's impulse being lessened, and in the blood being brought into as healthy a state as possible; whilst, in the anæmic form of the disease, an increase in the plasticity of the blood is essential for the cure of the case; for, as the occlusion and consolidation of the sac, after surgical procedure, depend on the same conditions being induced that are successful after medical treatment, the same constitutional means should be adopted in one case as in the other. Before proceeding to the employment of any direct surgical means for the cure of an external aneurism, it is necessary to ascertain that there is no internal aneurism present, and that the heart is free from disease. From want of this precaution, it has happened that patients have died on the operating table at the moment when the artery was being ligatured, or that they have expired shortly afterwards, from the disturbance of circulation consequent upon the necessary surgical procedures.

Surgeons are in possession of several modes of treating external aneurisms: viz., ligature, compression by instruments, flexion, digital compression, acupressure, manipulation, galvano-puncture, and injection.

Ligature.—The employment of the ligature was the only means adopted by surgeons, for the cure of aneurism, up to a very recent date; the use of compression in the treatment of the disease, as at present employed, being one of the most modern, as well as one of the greatest improvements, in surgical practice. The manner in which the ligature should be applied, and the various cautions respecting its use, have been sufficiently discussed (page 180 *et seq.*). The question as to the part of the vessel to which it should be applied in aneurism, remains for consideration; and this involves some important points.

Situation.—There are three situations in which the ligature may be applied: 1, *above and below the sac*, by the old operation; 2, on the *cardiac side* of the sac, by Anel's (Fig. 246) or Hunter's (Fig. 247) operation; 3, on the *distal side* of the sac, by Brasdor's or Wardrop's operation (Fig. 248).

Fig. 246. Fig. 247. Fig. 248.



Anel's operation. Hunter's operation. Distal operation.

1. The *application of the ligature on both sides of the aneurismal sac* is seldom practised at the present day, when the aneurism arises from disease of the coats of the vessel; but in those cases in which it occurs from traumatic causes, it may frequently be adopted as the best means of cure, even in aneurisms of the largest size, as has been mentioned in the chapter on traumatic aneurism. The older surgeons, however, were acquainted with this mode only of treating aneurisms. The mode of applying the ligature to both sides of the sac is as follows. After having arrested the circulation through the aneurism, by compressing the artery, leading to it either by means of a tourniquet, or where that is not applicable, by the pressure of an assistant's fingers, the surgeon slits up the sac, turns out the contained coagula and masses of fibrine, and then, passing a probe upwards and downwards into the artery, through the mouth of the sac, ties the vessel on each side, immediately above and below the aperture. This operation, as performed by the older surgeons on any of the larger arteries, as the popliteal, was not only so difficult in itself that surgeons were seldom willing to undertake it, but was so fatal in its results, being commonly attended by secondary

hemorrhage in consequence of the artery being ligatured in a diseased part, or by diffuse inflammation, suppuration, and gangrene in the deeper tissues of the limb operated upon, that recovery after its performance was considered a marvel, and most surgeons preferred submitting the patient to amputation at once, to the risk of so hazardous a procedure.

[This, the *old* operation, or that of Antyllus, has been, within a few years, revived and illustrated by several brilliantly successful cases in the hands of Mr. Syme. The only case of spontaneous aneurism in which I have seen it performed was one where the popliteal artery was affected, in which the sac had suppurated and burst, and in which the patient positively refused amputation. The operation was done by Dr. R. S. Kenderdine of this city, and it seems to me was the only admissible treatment under the circumstances: there was at no time any secondary hemorrhage, but the case unfortunately terminated fatally from pyæmia.—A.]

2. The *ligature of the artery on the cardiac side of the aneurism*, without opening the sac, was first done by Anel, in the year 1710, in a case of brachial aneurism. This operation, though attended with the risk of wounding or inflaming the sac, which was in close proximity to the seat of ligature, constituted a considerable advance in the treatment of the disease; inasmuch as it did not necessarily lead to the opening up of the aneurismal tumor, and to the dangers that were inseparable from that mode of procedure. As Anel, however, performed his operation as a mere matter of convenience in a particular case, and without the recognition of any new principle of treatment being involved in it, it attracted but little attention at the time, and does not appear to have been repeated by any of the surgeons of his day.

It was reserved for John Hunter to make the great improvement in operative surgery of *ligaturing the artery at a distance from the sac*, where its coats were healthy, and where there was no danger of interference with the aneurism itself. In this way the objections to Anel's operation were avoided: for though, like Anel, Hunter tied the artery on the cardiac side only of the sac, yet he differed from him in doing so in a healthy part of its course, and at a considerable distance above the tumor, where the application of the ligature would be attended with less risk of hemorrhage, and with no danger of opening, irritating, or inflaming the sac, which are inseparable from Anel's operation. The following are the reasons, given in Sir Everard Home's own words, that induced John Hunter to adopt the operation that is now generally known in surgery as the *Hunterian*. "Mr. Hunter proposed, in performing this operation, that the artery should be taken up at some distance from the diseased part, so as to diminish the risk of hemorrhage, and admit of the artery being more readily secured should any such accident happen. The force of the circulation being thus taken off from the aneurismal sac, the cause of the disease would, in Mr. Hunter's opinion, be removed; and he thought it highly probable that, if the parts were left to themselves, the sac, with the coagulated blood contained in it, might be absorbed, and the whole of the tumor removed by the action of the animal economy, which would consequently render any opening into the sac unnecessary."

Hunter's first operation was performed in December, 1785, in a case of popliteal aneurism, in which the femoral artery was ligatured rather below the middle of the thigh, underneath the sartorius muscle; and from that time his method was almost exclusively employed by surgeons in the treatment of aneurism, until the introduction of compression in 1842.

The *effects produced upon the aneurismal tumor* by the ligature of the vessel according to the Hunterian method, deserve careful attention. The immediate effects, on drawing tight the ligature, consist in a cessation of pulsation and bruit in the tumor, which at the same time subsides, becoming partially emptied of its blood. The supply of blood to the limb being in a great measure cut off, it becomes numb and cold, with a diminution of muscular power. The more remote effects consist in an increase of the activity of the collateral circulation, by which the vitality of the limb is maintained. At the same time, and, indeed, in consequence of this, the temperature of the limb often rises, until it becomes higher than that of its fellow.

[In several cases in which I have tied the femoral artery for popliteal aneurism, the *immediate* effect seemed to be an increase of temperature in the limb below the seat of operation. The same thing was observed in Dr. A. W. Smyth's remarkable case of successful ligation of the innominate, carotid, and vertebral arteries. (*Am. Journ. Med. Sciences*, July, 1866, p. 280.) The rise in temperature follows the ligation too quickly to be due to the establishment of the collateral circulation, and must, I think, be explained through the agency of the nervous system. Another

of the parts below the wound of operation. (*Proc. Path. Society*, in *Am. Journ. Med. Sciences*, July, 1867, p. 147.)—A.]

The consolidation of the aneurismal tumor begins as soon as the ligature is applied, and is usually completed in a few days, by changes taking place within it similar to those that occur in the spontaneous cure of the disease. This important change is effected by the gradual deposit of stratified and decolorized fibrine in concentric layers within the sac, and not by the sudden coagulation of its contents. For this deposition to take place, it is necessary that, though the direct flow of blood through the tumor be arrested by the ligature of the main trunk, some should yet be carried into it by collateral channels. This is a necessary condition for the success of the ligature; for, if it happen that all the flow of blood through the tumor is arrested, coagulation of that which happens to be contained in it will ensue, followed by gangrene, suppuration of the sac, and other unfavorable results; the coagulum appearing to act as a foreign body, and to be insusceptible of those changes that are necessary for the consolidation of the tumor. It is of importance to observe, that the proper consolidation of the aneurismal tumor, by the deposit of laminated fibrine, will occur even though a very considerable quantity of blood continue to flow through it. In the Museum of University College there is an exceedingly interesting preparation that illustrates this point. It is one in which Sir Charles Bell ligatured the femoral artery for popliteal aneurism. The patient died a week after the operation, from erysipelas; on examination, it was found, and is shown by the preparation that the femoral artery was double, and that, though only one portion of the vessel had been ligatured, the tumor, which continued to be supplied by the other, was completely consolidated. Hence it would appear that, if one half of the influx of blood only be arrested, obliteration of the sac by deposition of laminated fibrine may be expected to occur. After the aneurismal sac has been thus occluded, it progressively diminishes in size, and is at last converted into a small fibro-cellular mass. The artery that has been ligatured becomes closed at two points—at the part deligated (Fig. 249, *a*), and where it communicates with the sac (Fig. 249, *b*). In both these situations, it will be found to be converted into fibro-areolar tissue; whilst between them there is an open space, through the medium of which the collateral circulation is freely carried on.

Fig. 249.

Femoral artery ligatured for popliteal aneurism, obliterated at *a*, the site of the ligature, and at *b*, where the tumor has become consolidated and absorbed: between these points the artery is open.

3. *Distal ligature.*—In some cases in which the ligature cannot, for anatomical reasons, be applied on the proximal side of the aneurism, as in the arteries about the root of the neck, it was recommended by Brasdor that an endeavor should be made to obliterate the aneurism by ligaturing the vessel on its *distal* side. This operation was first practised by Deschamps, and has been especially commented upon by Wardrop. In principle, it resembles the Hunterian operation, the object being to arrest so much of the flow of blood through the sac that the consolidation of this may take place in the usual way, by the deposit of laminated fibrine. In the Hunterian operation, this is effected by deposit from the lessened quantity of blood that flows through the sac; in the distal operation, it is sought to be accomplished in the same way, and the success of the operation must necessarily depend, in a great measure, upon the extent to which the flow of blood through the sac is interfered with. This operation, however, is rarely successful; for, independently of the ordinary dangers resulting from the application of the ligature to a large vessel, the sac will continue to be distended with, and to receive the direct impulse of, the blood that is driven into it, though it be not transmitted through it; and hence, though the progress of the aneurism may be arrested for a time, it will often speedily increase again, and may perhaps eventually destroy the patient by suppuration and sloughing. Of 38 cases in which this operation has been practised on the carotid artery, in 25 instances a fatal result more or less speedily followed the operation; in the remaining 13 cases the patients survived the effects of

the ligature of the artery, though in very few if any cases were they cured of the disease for which the operation was practised. This operation, however, we shall consider more in detail in speaking of the particular cases in which it has been practised.

Indications and contraindications of ligature.—Ligature of an artery for aneurism, by the Hunterian method, succeeds best in those cases in which the tumor is circumscribed, of moderate size, slow in its growth, having a tendency to consolidation, and unaccompanied by much œdema of the limb. When the aneurism is undergoing spontaneous cure, no surgical interference should be employed, but the case left to nature. In this way it occasionally happens, during the preparatory treatment of the disease, that the aneurism becomes consolidated.

All operation should be avoided when there is any serious disease in the heart, and in cases of multiple aneurism where the second tumor is situated internally; but it has happened that two aneurisms in one limb, as of the popliteal and femoral arteries, have been cured by one ligature applied to the external iliac. Two aneurisms seated in corresponding parts of opposite limbs, affecting, for instance, the two popliteal arteries, may be successfully operated upon. But, if two aneurisms be seated on different parts of the body, as the axilla and groin, for instance, at the same time, the aneurismal diathesis would be indicated, and it would certainly not be expedient to operate.

In certain cases, the Hunterian operation seldom succeeds; and these, therefore, may be considered as unpromising to it. This happens in those instances in which it is necessary to apply the ligature very close to the sac, so as indeed rather to perform Anel's operation, as here there is the double danger of inflaming or wounding the sac, and of interfering with the collateral circulation of the limb. Those cases, also, in which the aneurism is very acute in its progress, increasing rapidly with forcible pulsation, having very fluid contents, and a large mouth to the sac, into which the blood is consequently driven by a full wave at each pulsation of the heart, are rarely favorable for the use of the ligature, inasmuch as stratification seldom occurs. When the aneurism is situated in the midst of loose and very yielding tissues, as in the axilla, where it readily expands to a large size, not being bound down by the surrounding parts, suppuration and sloughing of the sac are especially apt to occur after ligature. When it is diffused widely through the limb, with coldness and a tendency to incipient gangrene, the circulation of blood through the part is so much choked that the deligation of the vessel will in all probability arrest it entirely, and thus produce mortification. When arteries can be felt to be calcified, it is a question whether they can be safely ligatured, as in all probability they will be cut or broken through by the noose, and the changes necessary for their occlusion will not take place. Porter, however, recommends that the ligature should be applied in such cases, though I cannot but doubt the propriety of this advice. When inflammation has been set up in the sac, with a tendency to suppuration of the tumor, it is a debatable question whether the ligature should be applied or not. In these cases I agree with Hodgson, that the artery should be tied; for even if the sac eventually suppurate, there will be less risk to the patient if this event occur after the application of the ligature, than if it happen while the artery leading into the tumor is pervious. If suppuration have already taken place in or around the sac, the application of the ligature above the inflamed tumor on the point of bursting would be worse than useless. In such cases, the line of practice must be determined by the seat of the aneurism. If this be in the axilla, groin, or neck, it should be laid freely open, the coagula scooped out, and the artery tied above and below the mouth of the sac—a most formidable and doubtful operation, but the only one that holds out a chance of success. If the aneurism be in the ham or calf, amputation would probably be the best course to pursue.

[In cases of *suppurating* axillary aneurism, amputation at the shoulder-joint might be practised, and would probably be safer than either ligation of the subclavian or opening the sac. Hemorrhage during the operation could be controlled by pressure made through an incision above the clavicle, as practised by Mr. Syme. (*Observations in Clinical Surgery*, p. 148.)—A.]

In some instances, there is no resource left to the surgeon but to amputate. 1. Amputation must be performed when the aneurism is associated with carious bone or diseased joint, as when popliteal aneurism has produced destruction of the knee. 2. If the aneurism have attained so great a magnitude that it has already interfered

seriously with the circulation through the limb, as indicated by considerable œdema, lividity, and coldness of the part, with distension of the superficial veins, it is a question whether the application of the ligature may not immediately induce gangrene, and whether the patient would not have the best chance of recovery by submitting to amputation at once; this is more particularly the case when the aneurism, whether previously large or small, has become diffused with impending gangrene, when removal of the limb must not be delayed. 3. If gangrene have actually supervened, and the patient's strength be sufficient to bear the operation, amputation should be done without delay. 4. If a diffused aneurism, whether suppurating or not, on the lower extremity, have been opened by mistake for an abscess, there is no resource left but immediate amputation.

The ligature fails from various causes in a very considerable number of the cases in which it is employed for the cure of aneurism. Thus, in 256 cases of ligature of the larger arteries for aneurism, collected and tabulated by Crisp, it would appear that the mortality amounted to about 22 per cent. And Porta finds that, among 600 cases of ligature of arteries for diseases and injuries of all kinds, the mortality amounted to 27 per cent. It must be borne in mind, that these are collections of previously reported cases, and that, if the unrecorded cases could be got at, the rate of death would, in all probability, be found to be much higher even than that above stated.

Accidents after Ligature for Aneurism.—The accidents that may follow the application of the ligature in a case of aneurism, are: 1, secondary hemorrhage from the seat of ligature; 2, the continuance or the return of pulsation in the sac; 3, the occurrence of suppuration and sloughing of the tumor, with or without hemorrhage from it; and 4, gangrene of the limb.

1. *Secondary hemorrhage* from the seat of ligature presents nothing peculiar, and has already been discussed at page 193.

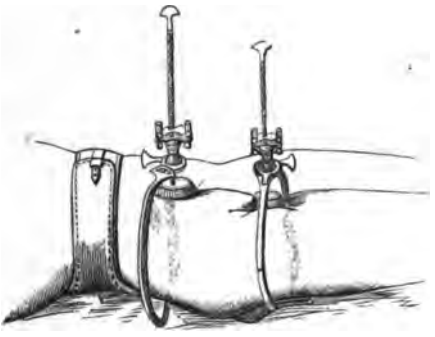
2. The *continuance or return of pulsation in an aneurismal sac* after the ligation of the artery leading to it, is an interesting phenomenon, and one that deserves some attention. When the Hunterian operation is successfully performed, though the pulsation in the sac be entirely arrested, a certain quantity of blood continues to be conveyed into and through it by the anastomosing channels, and it is from this that is deposited the laminated fibrine by which the consolidation of the tumor is ultimately effected. This stream of blood furnished by regurgitation, or by transmission through the smaller collateral channels, is continuous, and not pulsatory; occasionally, however, it is transmitted in sufficient quantity by some more than usually direct and open anastomosing or feeding branch, and thus gives rise to a continuance or to a return of the pulsation. It is interesting to observe that, in some of the cases in which this has happened, there has been a return of the bruit, but in the majority no sound appears to have been emitted.

The *period* of the return of the pulsation in the sac after the ligature of the artery varies greatly. In by far the majority of cases, at least two-thirds of those in which it has happened, a certain degree of thrill or of indistinct pulsation has been found in the sac shortly after the application of the ligature; at all events within the first twenty-four hours. This may be looked upon as being rather a favorable sign than otherwise, as it is indicative of the free state of the collateral circulation, and generally soon disappears spontaneously, the sac undergoing consolidation. Next in order of frequency are those cases in which the pulsation returns in about a month or six weeks after the ligature of the artery, when the collateral circulation has been fully established, and, after continuing for some length of time, gradually ceases. It more rarely happens that the pulsation returns between these two periods; that is to say, about ten days or a fortnight after the application of the ligature; though in some instances the slight vibratory thrill, scarcely amounting to a pulsation, which perhaps is perceptible a few hours after an artery has been tied, gradually strengthens at the end of a week or ten days into as distinct and forcible a beat as had been noticed before the operation. In some rare instances the pulsation has reappeared after the lapse of some months, the aneurismal tumor having in the meanwhile undergone absorption; then indeed it may with justice be looked upon as constituting a *secondary aneurism*, and as indicating a recurrence of the complaint.

The *cause* of the continuance or of the return of the pulsation in an aneurismal sac, must be looked for in too great a freedom of the collateral circulation. Indeed, I consider it an essential requisite for the manifestation of this phenomenon, that

compression employed in London by means of the horse-shoe tourniquet, much inconvenience resulted from want of attention to this particular. The tendency to fretting of the skin is much lessened by powdering the limb; and the removal of the cuticular hairs by shaving, diminishes materially the irritation produced by the instrument. In order to keep up continuous pressure, and at the same time to prevent any one part of the skin from being injuriously galled, it is of very great consequence that two instruments should be used at the same time, so that when one is screwed up the other may be loose; these instruments need not be placed closely together. If the aneurism be in the ham, it will be sufficient for one (Fig. 253) to be applied to the groin, whilst the other (Fig. 254) is put upon the middle of the thigh (Fig. 255). In using the instrument, the great point, as Tufnell most properly remarks, is to control the circulation with the minimum of pressure. In order to do this the first instrument should be screwed up so that all pulsation ceases in the tumor, but still not so tightly as completely to arrest all the flow of blood through it. As the pressure exercised by this becomes painful, the second one must be screwed tight, and then the first compressor may be slackened. In this way an alternation of pressure can be kept up without much pain or inconvenience. If possible, the patient should be taught how to manage the instrument himself, and will often find occupation and amusement in doing so. If, however, it excite much pain or irritation, as it does in some subjects, it may be necessary to give opiates. The pressure should, if possible, be continued during sleep; but if it prevent the patient from taking his natural rest, the suggestion made by Tufnell, of unscrewing the instrument slightly, and, when the patient is asleep, gently tightening it again without awakening him, may advantageously be adopted; it is indeed surprising how very little unscrewing will relieve the pain of the compression. A large cradle should be placed over the patient's body, so that the weight of the bed-clothes may be taken off the apparatus, and that the patient may manage it without risk of disturbance. Should there still be much uneasiness, the instrument might be taken off for a few hours, and compression kept up in an intermittent manner. Even under such circumstances as these, consolidation of the sac may ensue.

Fig. 255.



Two compressors applied for femoro-popliteal aneurism.

In some cases, where, from the situation of the aneurism, deep and severe pressure is required to control the circulation, the pain becomes so unendurable that the patient cannot submit to the treatment sufficiently long for a good effect to be produced. In these circumstances, chloroform becomes a most useful adjunct; and, by maintaining the anæsthesia for several hours, the amount and duration of pressure requisite to effect a cure may be maintained. In this way W. Murray of Newcastle-on-Tyne cured an aneurism of the abdominal aorta by keeping up pressure on that vessel for five hours under chloroform. Heath of the same town cured an aneurism of the external iliac by compressing the abdominal aorta for seven hours under chloroform; and Mapother of Dublin has treated an ilio-femoral aneurism successfully by compressing the common iliac artery for four and a half hours. By these means the only serious objection as to the employment of pressure, and almost the only cause of failure, may be prevented; and it is clear that, under chloroform, pressure may be applied to arteries, such as the subclavian and carotid, on which it could not otherwise be used.

The *effects* upon the tumor vary considerably. In some cases it rapidly and suddenly solidifies; more commonly, however, this is a gradual process, the aneurism becoming more painful and solid, with less pulsation and bruit. As the solidification takes place, there is usually a good deal of restlessness, a feeling of general uneasiness, and of constitutional disturbance, which is best quieted by opiates. As the pressure is continued, and the tumor begins to harden, the anastomosing vessels enlarge, with a good deal of burning pain in the limb generally, and arterial pulsations in situations where usually none are felt. The abnormal pulsation, in these

cases, is always found to occur in much the same situations, the same vessels appearing to undergo dilatation. Thus Tufnell has made a remark, which I have had more than one opportunity of verifying, that, in the treatment of popliteal aneurism by compression, three arteries will be found to be enlarged, one of which passes over the centre of the tumor, another over the head of the fibula, and the third along the inner edge of the patella; he also states that the severe burning pain which is felt in these cases is owing to the artery accompanying the communicans peronei nerve being enlarged. After complete solidification of the tumor has taken place, the compression ought to be continued for at least forty-eight hours, so as to secure against the occurrence of a relapse.

The *duration* of the treatment varies very greatly. In some cases, as above stated, the tumor has become solidified from a few hours to two or three days. In other instances, the treatment has required to be protracted for more than three months before a cure resulted. Of 26 cases of femoral or popliteal aneurism cured by compression in the London hospitals, the average time, according to Hutchinson, was nineteen days. Much of course will depend, in this respect, on the constitution of the patient, and on the condition of the tumor; those circumstances which are most favorable to the spontaneous cure of the aneurism will also influence the rapidity of the cure by compression. In the early days of the compression treatment, there was an indisposition on the part of surgeons to apply it very effectually and firmly, and a longer time was expended over it than is now generally the case, and the example set by Murray, with regard to abdominal aneurism, has been followed in respect to the femoral, popliteal, and other forms of the disease.

Applicability.—Of the great value of compression in the treatment of aneurism there can be no doubt; more especially when the tumor is situated in the arteries of the lower extremity below the middle of the thigh. In aneurisms occurring in the vicinity of the trunk, as in the iliac, the carotid, subclavian, and axillary arteries, it is not so applicable. Spontaneous aneurism is extremely rare in the upper extremity; and, as the traumatic forms of the disease which occur here generally require that the sac should be laid open, it is seldom found necessary to have recourse to it in this part of the body, though it may be and has been successfully applied to the brachial artery.

The great question with regard to compression appears to me, after all, to be whether it possesses any special advantages over the ligature, in the treatment of femoral and popliteal aneurisms, to which its employment is necessarily chiefly confined. The principal objections that have been urged against compression are, that its employment is more painful and tedious than the use of the ligature; and that those cases that are unpromising to the ligature, or that require amputation rather than it, are equally unfavorable to compression, and cannot be saved by its employment.

To these objections I think it may with justice be answered, that the pain attendant on the employment of compression depends very greatly upon the skill and care with which the apparatus is applied and managed throughout, as well as upon the kind of instrument used, being certainly much diminished when Carte's elastic compressor is employed; and that, as has already been shown, the pain may be overcome by the use of anæsthetics. With regard to the relative tediousness of the treatment under the two plans, it would appear that in reality there is but little difference; for although some cases, in which compression is used, are prolonged over a considerable space of time, yet they do not occupy more than is often consumed when accidents of various kinds follow the use of the ligature; and it not unfrequently happens in compression, but can never occur after the employment of the ligature, that the patient is cured of his disease in a few hours or days. Taking, however, the averages, we find that in the Dublin cases the treatment lasted twenty-five days, and in the London cases but nineteen, and this is not very different from what happens with the ligature; for, of 54 cases recorded by Crisp, in which the femoral artery was tied, the average time for the separation of the ligature was eighteen days, and if to this a week more be added for the closure of the wound, and for the treatment of the various accidents often accompanying and following ligature, we should probably be within the mark, and yet only bring the duration of the treatment of the two methods to the same level.

After all, surgeons will eventually be guided in their estimate of the value of these two plans, not so much by the question of submitting their patients to a slightly

more painful or tedious treatment, as by the comparative risk of life attendant upon one or other method. Upon this point the statistics have yet to be made; partly because cases of the treatment of aneurism by compression have not yet been sufficiently numerous, and partly because the unsuccessful cases of ligature have not been so commonly published as the successful ones. If, however, we compare the 32 cases of femoral and popliteal aneurism treated in Dublin up to February, 1851, as given by Bellingham (*Med.-Chirurg. Transactions*, vol. 34), with the results of 188 cases of femoral and popliteal aneurism, recorded by Norris, in which the artery was ligatured, we shall find that of the 32 compression-cases 26 were cured; in 1, the ligature was applied after pressure had failed; in 2, amputation was performed; in 1, death occurred from erysipelas; in 1, from chest-disease; and in 1 case the pressure was discontinued. Thus it would appear that 6 out of the 32 failed, being in the proportion of 1 to 5.3 cases, and 2 died, being in the ratio of 1 to 16. Of the 188 cases in which the artery was ligatured, 142 were cured, 46 died, 6 were amputated, in 10 the sac suppurated, and in 2 gangrene of the foot occurred. Thus the deaths after ligature were in the proportion of 1 to 4, and the failures or serious accidents in that of 1 to 3, showing clearly a very considerable preponderance in favor of the treatment by compression. Besides this, in many patients who recovered after the ligature, various accidents, such as gangrene, erysipelas, secondary hemorrhage, &c., resulted as the direct consequences of the treatment; and these do not happen when pressure is employed.

If compression fail, ligature may often be advantageously applied; in some cases with a better prospect of success than if compression had not previously been tried, that treatment having caused the collateral circulation to enlarge, and thus lessened the tendency to gangrene. If, however, we take the general average of those cases that have been submitted to ligature after the failure of compression, we shall find that the result is not so satisfactory as when the ligature has been employed as the primary method of treatment. Thus I find that out of 40 cases in which the ligature has been employed after compression has failed, there have been 16 deaths. This is probably not so much due to the previous employment of compression, as to the same causes interfering with the consolidation of the tumor after the ligature that had prevented the success of the compression treatment.

[Previous compression does, however, directly diminish the chances of successful ligation, by increasing the tendency to venous congestion and, therefore, to gangrene.—A.]

It should also not be forgotten that in some cases, as when aneurism is complicated with heart disease, or occurs in a very broken and unhealthy constitution, in which the operation necessary for the application of the ligature would scarcely or not at all be admissible, compression may be safely employed.

After carefully considering the relative merits of the two plans of treatment, I think we may conclude that, though in some few cases neither ligature nor compression can be adopted, and amputation is the sole resource, yet in others compression can be employed when it would not be safe to have recourse to the use of the ligature; and that, in all ordinary cases of femoral and popliteal aneurism especially, compression should be preferred to the ligature, inasmuch as it is not a more tedious, and an infinitely safer method of cure. At the same time, it must not be forgotten that its success depends very greatly on the continuous care bestowed upon the case during the progress of the treatment.

[Ligation of the femoral artery, though not a difficult, is a very delicate operation. If, however, it be done with due care, *when the aneurism is of moderate size*, it is, I believe, a much more successful operation than it is usually considered. For well selected cases, I cannot help thinking, with Mr. Syme, that it is the best mode of treatment.—A.]

Flexion.—The treatment of aneurism by compression has of late been much simplified, and all apparatus dispensed with, by two methods; in one of which the artery and aneurism are compressed by the *flexion* of the contiguous joint, while in the other the artery is compressed by the finger alone.

The treatment of aneurism by the flexion of the contiguous joint is, of course, applicable in those cases only in which the disease is situated opposite to and inside the flexion of a joint, as in the popliteal cavity, at the bend of the arm, and possibly in the axilla. It is in cases of popliteal aneurism that this method of treatment is

specially applicable; and the merit of first successfully employing it in this disease is undoubtedly due to E. Hart.

Nothing can be simpler than this plan. It consists in flexing the leg upon the thigh, so that the heel is brought up towards the buttock, where it is retained by a strap or bandage. The patient is at the same time confined to bed, and put under proper constitutional treatment. By this means, the popliteal artery being bent at an acute angle, the circulation through it is nearly, if not completely arrested; and the obstacle to the flow of blood is still further increased by the compression of the tumor between the posterior flat surface of the femur and the upper part of the calf. In this way the aneurism is most favorably situated for the consolidation of its contents, which, in the cases recorded, has taken place at an early period.

In order that this plan may be successfully carried out, the limb should be bandaged, and then at first gently flexed, the bending being gradually increased as the patient can bear it. Great care should be taken not to make the flexion too forcible at first, and not to place the limb in a position that would be irksome or painful to the patient. The principle on which the cure is effected in these cases appears to be, that by flexion the artery leading to and from the sac, and the aneurism itself, are so compressed that retardation of the circulation ensues, and deposition of laminated fibrine takes place in the usual way.

The compression by flexion, like every other method of treating aneurisms, occasionally fails. It is most likely to be attended by success in those cases in which the aneurism is small, situated low in the popliteal space, and in a young or middle-aged subject, who can bear the continued flexion without much inconvenience.

The good effects of flexion would probably be much increased by the simultaneous employment of digital compression. Should this method of treatment fail, compression by instruments or ligature can be had recourse to as readily as they might have been in the first instance.

Digital Compression.—The treatment by *digital compression* was first employed by Vanzetti, of Padua. In this plan of treating aneurisms no apparatus of any kind is used; but the circulation through the artery leading to the tumor is controlled by the pressure of the finger. In order to carry it out efficiently there must be relays of assistants, each one of whom compresses the vessel for about ten minutes at a time. So soon as his finger becomes fatigued, but before he relaxes the pressure, another assistant compresses the vessel; and thus the circulation through it may be uninterruptedly controlled. In this way aneurisms of the popliteal artery, in the orbit, at the bend of the arm, and even, it is said, in the groin, have been successfully treated—the tumor having in some instances become consolidated in a few hours. The effect of the treatment and the rapidity of cure, would be increased by the application of direct pressure to the tumor, or by manipulation and by the previous employment of proper constitutional means. It might be very advantageously conjoined with the treatment by flexion; but its great advantage seems to be, that it is applicable to arteries at the root of the neck, to which it might be difficult to apply any kind of compressor, or when the surgeon is so placed as not to be able to obtain such an apparatus.

[Great stress has recently been laid upon the necessity of the sac being distended with blood before the compression is begun; this may easily be effected by making *distal* compression for a few seconds before applying pressure on the proximal side of the aneurism.—A.]

Acupressure has been employed in the treatment of some cases of aneurism. This remedy, however, though deserving of trial, requires further observation before its proper value can be determined.

Manipulation.—Sir W. Fergusson has proposed to treat some aneurisms by a procedure which he terms *manipulation*. This consists in squeezing the aneurismal tumor in such a way as to detach a portion of the coagulum within it, which being carried on with the current of blood into the distal end of the artery, obstructs this; and thus, by impeding the circulation through the sac, may lead to the gradual consolidation of the tumor. This procedure has as yet been employed to too limited an extent to enable us to form an estimate of its value, and can scarcely be considered, nor is it intended to be, of very general application. To aneurisms, however, that are not amenable to ordinary surgical treatment, and that must necessarily prove fatal if left, as those situated at the root of the neck, more particu-

larly of the subclavian artery, it might possibly be advantageously applied. It is scarcely necessary, however, to point out the obvious danger of rupture of the sac, or of the diffusion of the aneurism on the separation of the coagulum, to make surgeons adopt due caution in carrying out this method of treatment. There is another danger also especially attendant on this procedure, when applied to aneurisms about the neck; viz., that the detached coagulum may be carried by the circulation into the cerebral arteries, and by obstructing them occasion the same kind of cerebral disturbance that occurs when these vessels become occluded by fibrinous plugs —embola. That this danger is a real and a great one, is evident from the fact that, in several cases in which manipulation of subclavian and carotid aneurisms has been tried, the patient has been suddenly seized with syncope and hemiplegia. Teale has successfully conjoined manipulation with compression in a case of popliteal aneurism, in which the pressure on the artery was slow in consolidating the tumor; the detachment of a portion of the coagulum almost at once led to the consolidation of the tumor.

Galvano-puncture.—The attempt to procure consolidation of an aneurismal sac by the employment of *electricity* or *galvanism* is of comparatively recent date. It appears to have been first practised by B. Phillips, about the year 1832. Little attention, however, was given to this mode of treatment until a few years back, when it was revived by some of the French and Italian surgeons, especially by Pétrequin and Burci. The principle on which this operation is conducted consists in endeavoring to produce coagulation in the aneurismal sac, by decomposing the blood contained in it by means of the galvanic current. In some instances the attempt to do so has induced inflammation of the sac and of the surrounding structures, and in all it must occasion the liability to this; as the change that is sought to be effected in the contained blood, consists not in the deposition of its fibrine, but in the coagulation of it *en masse*. It has of late been recommended to conjoin the employment of compression of the artery, either above or below the sac, with the transmission of the galvanic current through it; there being in this way less liability for the coagulum that is deposited to be broken down and washed away, than would happen if the current of blood were allowed to pass through the sac whilst it is in the act of forming.

The coagulation of the blood is effected by introducing two acupuncture needles into the sac in opposite directions, and keeping them in contact with one another, after connecting them with a galvanic battery of moderate tension; coagulum becomes deposited around one of the needles. The operation should be continued for periods varying from ten minutes to a quarter of an hour, and requires to be repeated several times. Pétrequin recommends that the direction of the current be changed from time to time, so that a number of clots may be formed in the sac. In this way a soft mass of coagulum may occasionally be formed in the tumor, so as to fill it up more or less completely, and to prevent the passage of blood through it. Occasionally it happens, however, that the blood has continued fluid, and the sac pervious, no coagulation having been effected; and in other instances, the amount of inflammation that has been set up in the sac has been so great as to give rise to its sloughing, to the occurrence of secondary hemorrhage from it, and to the loss of the patient's limb or life. This inflammation may, in some cases, doubtless have been the result of the injury inflicted upon the sac by the introduction of the needles, and by the charring of the tissues by them; but in other cases, I think it probable that it may have taken place from the rapid coagulation of the contained blood, an occurrence which, as we have already seen, tends especially to inflammation, suppuration, and sloughing of the aneurismal sac. The pain of the operation is always very considerable; so much so, that patients who have been subjected to it once have refused to submit to a repetition of it.

Up to July, 1851, Bonnet had collected 23 cases of aneurism treated in this way; of these, 8 were of the brachial artery, 7 of the popliteal, 2 of the subclavian, and 1 each of the following: the ophthalmic, the temporal, the carotid, the thoracic aorta, the ulnar, and one unknown. Of these the proceeding failed in 13 instances; 9 cases were reported as successful, but in 7 of these Bonnet states that doubts must be entertained both as to the results and as to the treatment, for the cure took place not by galvano-puncture alone, but in some by the conjoined influence of compression and the application of ice; and in others as the result of inflammation and suppuration of the sac. There are consequently only two cases in which the cure can

among some of the first symptoms, the patient often experiences sharp shooting pains, apparently of a rheumatic or neuralgic character, in the arm and the side of the head and face, arising from pressure upon, and irritation of, the cervical and brachial plexuses of nerves. Taking the course of the ascending and descending filaments of the cervical plexus, the pain shoots up the side of the head and neck, over the shoulder and upper part of the chest; or, from pressure upon the brachial plexus, it radiates down the hand and arm, being usually especially severe about the elbow and fingers. The muscular power of the right arm also commonly becomes impaired.

Fig. 259.

Aneurism of the innominate artery compressing and stretching the recurrent laryngeal nerve, and pushing the trachea to the left side. (Back view.)

Dyspnœa is of very common occurrence, and of very varying degrees of intensity, from slight difficulty in breathing up to fatal asphyxia. It may proceed either from irritation of the larynx, in consequence of compression of the recurrent nerve; or from pressure on the trachea or on the right bronchus. When it depends on laryngeal irritation, the voice is hoarse, husky, or whispering; and there is a dry, croupy, and paroxysmal cough, usually accompanied by expectoration of frothy serous mucus. In these cases, after death, the recurrent nerve will be found to be stretched out and greatly elongated by the pressure of the tumor (Fig. 259). Compression of the trachea, which becomes flattened and curved over to the left side by the protrusion of the tumor, is a common cause of dyspnœa, and is not unfrequently associated with the laryngeal irritation. More rarely by far, the right bronchus is compressed by the extension of the tumor downwards.

Dysphagia is of sufficiently frequent occurrence, and varies from slight uneasiness in deglutition to an impossibility in swallowing anything except fluids. I have never seen it occur without having been preceded by dyspnœa; and, in every instance that has fallen under my observation, it has been associated with laryngeal irritation. This coincidence of these two symptoms is readily explained by the anatomy of the parts; the recurrent nerve, lying between the artery and œsophagus, must suffer compression before the mucous canal can be interfered with.

Prognosis.—The prognosis of brachio-cephalic aneurism is in the highest degree unfavorable, though the disease frequently does not run a rapid course. If it extend upwards and outwards, the tumor may acquire a very large size before any very important organ or part is implicated; but if it press backwards and inwards, it may prove fatal at an early period. I know of no case in which such an aneurism, if left to itself, has undergone spontaneous cure, and but few instances in which the rupture of the sac has taken place. The most frequent cause of death is asphyxia, from spasmodic closure of the larynx induced by irritation of the recurrent nerve; or from pressure on the trachea.

Treatment.—There are several instances on record in which a properly conducted course of constitutional treatment has cured a patient: thus, a case of Luke's was permanently cured by small and repeated bleedings, conjoined with the administration of digitalis. In connection with such treatment, distal pressure might be employed, as in a case that derived benefit from this plan in Syme's hands.

In aneurism of the innominata, the vessel is so short and the sac so situated that it is impossible to attempt to apply a ligature on the cardiac side of the tumor. What resource, then, does surgery offer in these cases beyond the employment of constitutional and dietetic means? It may be answered to this, that, if these measures fail in arresting the disease, our choice must lie between two alternatives; leaving the patient to his fate, or having recourse to the application of the ligature on the distal side of the tumor. On looking on the innominate artery with reference to the distal operation, we are struck by two peculiarities in the vessel, which must necessarily modify to a considerable extent not only the seat of the operation, but the principle on which it is conducted. The first peculiarity to which I allude

is the shortness of the trunk, which makes it impossible to apply the ligature to the vessel itself, but renders it necessary to deligate one or both of its terminal branches. The other peculiarity is, that under no circumstance can these vessels be so ligatured as to arrest the whole of the blood sent into the artery; for, although the circulation through the carotid may be entirely stopped, yet it is impossible, from the seat and extent of the disease, to tie the subclavian at any point except beyond the scaleni; hence that blood which is destined for the supply of the branches of this vessel—the vertebrals, the thyroid axis, the internal mammary, and the first intercostal—must continue to be propelled into and through the sac. Three distinct modifications of the distal operation have been proposed and resorted to for the cure of aneurisms in this situation: 1. Ligature of the subclavian alone; 2. Ligature of the carotid alone; and 3. Ligature of both vessels with an interval of greater or less extent.

1. *Ligature of the subclavian only* (Fig. 260, p. 627) has been practised in four cases, the results of which are exhibited in the accompanying table; two were soon fatal, and the partial success in one of the other cases may be fairly attributed in a great measure to the accident of the carotid having been occluded. The results of this practice have certainly not been sufficiently favorable to justify the surgeon in repeating an attempt of this kind, opposed as it is to the known principles on which the distal operation effects a cure. For, supposing, as we may safely do, with Wardrop, that only one-third of the blood that is sent into the innominata finds its way through the extra-scalenal portion of the subclavian, the remainder being destined for its branches and the carotid in equal proportions, what fact can be adduced or principle laid down from which we can expect to obtain the cure of an aneurism in close proximity to the heart, by cutting off so small a proportion as one-third of the supply of the blood sent into it.

Aneurisms of Innominata Treated by Ligature of Subclavian only.

Operator.	Sex.	Age	Result.	Cause of Death.	Remarks.
1. Dupuytren,	m.	40	Died on ninth day.	Exhaustion following cough, and secondary hemorrhage.	Subclavian ligatured immediately above clavicle. Tumor diminished, but pulsations continued. Aneurism of subclavian, with dilatation of the innominata and aorta.
2. Wardrop, 1827.	f.	45	Died two years after operation.	Exhaustion.	Subclavian ligatured beyond scaleni; the pulsations in and size of tumor diminished, and respiration became freer; on the ninth day pulsation reappeared in right carotid, in which it had previously been absent. (We may ascribe success of operation to this circumstance.)
3. Laugier, 1834.	m.	57	Died a month after operation.	Asphyxia.	Vessel ligatured immediately above clavicle. Aneurism of brachio-cephalic; aorta was dilated, and right carotid obliterated by the pressure of the tumor.
4. Broca, 1862.	m.	50	Died six months after operation.	Gangrene of lung.	Tumor had not much diminished, but became harder. Afterwards increased in size.

2. *Ligature of the carotid only* (Fig. 261, p. 627) has been practised in ten cases, as recorded in the annexed table, and in one case only does the disease appear to have been materially benefited; and in that instance the good effects can scarcely be attributed to the operation, but must rather be looked upon as an effort of nature to effect a spontaneous cure, the sac becoming inflamed and suppurating, and the arteries of the arm and head on the side affected undergoing obliteration. Key's patient died in consequence of the left carotid becoming occluded, and the brain being deprived of its proper supply of blood.

[Dr. Addinell Hewson has tied the carotid for innominate aneurism, the patient dying on the eleventh day, and the autopsy showing that the aorta itself was involved in the disease. (*Pennsylvania Hosp. Reports*, vol. i. pp. 219–243.)—A.]

Aneurisms of Innominata Treated by Ligature of Carotid only.[1]

Operator.	Sex.	Age.	Result.	Cause of Death.	Remarks.
1. Evans, 1828.	m.	30	Recovered: living in 1863—thirty-four years after operation.	.....	Tumor diminished for a few days after operation, but at end of seven days inflammation of the sac set in, followed by obliteration of arteries of right arm and the branches of the carotid. At the end of a year tumor still existed, with constant pulsation. Next year the sac suppurated, and discharged much pus.
2. Mott, 1829.	m.	55	Died seven months after operation.	Asphyxia.	After operation, radial pulse on affected side disappeared; and tumor in neck was much diminished. After death, no external appearance of tumor; internally it was as large as a double fist.
3. Aston Key, 1830.	f.	61	Died a few hours after operation.	Narrowing of vertebral arteries; brain not receiving sufficient blood for its functions.	Aneurism of innominata and of arch of aorta found. The orifice of left carotid nearly occluded, and vertebrals smaller than natural.
4. Morrison, 1832.	m.	42	Recovered from operation, died twenty months afterwards.	Suddenly; cause not stated.	Aneurism of innominata and carotid found. Arch of aorta diseased. Right carotid dilated into a sac as high as part ligatured, and plugged by dense fibrinous laminæ.
5. Fergusson, 1841.	m.	56	Died on seventh day.	Pneumonia.	Tumor and pulsation decreased after operation. Tumor nearly filled with firm laminated coagulum; no plug in carotid.
6. Hutton, 1842.	m.	47	Died on sixty-sixth day.	Bronchitis, inflammation, suppuration, and ulceration of sac into trachea.	Tumor diminished after ligature. Size and pulsation less. After death, tumor contained purulent matter, and grumous blood; had opened into trachea. Right carotid and subclavian contained firm coagula.
7. Campbell, 1844.	m.	48	Died on nineteenth day.	Pneumonia.	Tumor began to disappear after the vessel was ligatured. After death, aneurism of innominata and transverse portion of arch, and dilatation of aorta as far as diaphragm.
8. Wright, (Montreal), 1855.	m.	70	Died on sixtieth day.	Hemiplegia.	Tumor solidified by laminated fibrine. Subclavian pervious, with canal through tumor leading to it.
9. Broadbent.	m.	50	Died on one hundred and fifteenth day.	Exhaustion from secondary hemorrhage.	No alteration produced in tumor by the ligature. Secondary hemorrhage recurred several times.
10. A. Newton.	m.	...	Died on twelfth day.	Effusion into chest.	

3. In seven cases *both the carotid and subclavian arteries* have been tied (Fig. 262). In one of the most favorable of these, that by Fearn, two years elapsed between the ligature of the carotid and that of the subclavian; the patient dying three months after the second operation: the sac was filled with laminated coagulum, and appeared to be undergoing spontaneous cure. (*See* Table, next page.) The third case is remarkable as being the first instance in which both the vessels were tied simultaneously, and from the patient having lived for six days after the occlusion of all the arteries supplying the brain except the left vertebral. Heath's case is remarkable, as being the first in which simultaneous ligature of both arteries was followed by recovery.

[1] Besides the cases referred to in this Table, fatal cases are recorded by Neumeister (1830—death on the fifth day); John Scott (1834); Dohlhoff (1867—death on the sixth day); Porta (1842—death in forty hours); Vitardebo (1843—death on the twenty-first day); Rompani (1844—death on the twenty-first day); and Adile. Pirogoff relates two cases of recovery after ligature of the carotid for aneurism of the innominate artery.

for a considerable number of years without giving rise to any special inconvenience: this is more particularly the case when they are seated at the bifurcation of the artery; when at the root, they are more likely to be attended by injurious pressure-effects.

Treatment.—Since the time when Sir A. Cooper first ligatured the carotid, in 1805, the only means on which the surgeon relies for the cure of aneurism of this vessel is deligation of the artery at a distance from the sac. When the aneurism is so situated that a sufficient extent of healthy vessel exists between the sternum and the base of the tumor to admit of the application of a ligature, the Hunterian operation may be practised. If, however, the root or lower portion of the artery be so involved that there is no room to apply the ligature between the heart and the seat of the disease, the distal operation may be performed.

Ligature of the Carotid.—When the surgeon can choose the seat at which to ligature the artery, he usually selects the part of the vessel which bisects the angle formed by the anterior edge of the sterno-mastoid with the omo-hyoid muscle. The artery is reached by making an incision, about three inches long, over its course upon the anterior edge of the sterno-mastoid, which is the directing line and a sure guide to the artery. After dividing the integument, the subcutaneous fascia, and areolar tissue, the sheath of the vessel is exposed. This must then be carefully opened, any branches of the descendens noni being avoided, and the ligature passed from without inwards, between the vein and artery. In performing this operation, subcutaneous vessels are occasionally wounded, which may bleed rather freely; if so, they should be ligatured. When the sheath is opened, the jugular vein sometimes swells up considerably, so as to obscure the artery; but by being drawn aside with a retractor, or repressed by the assistant's finger, all difficulty from this source will cease. The pneumogastric nerve is not seen, being drawn aside with the vein. If the aneurism have attained a very considerable size, extending low in the neck, and not leaving, perhaps, more than one inch of clear space above the clavicle for the surgeon to operate in, the difficulties are necessarily very greatly increased; and here the best plan will be to divide the tendon of the sterno-mastoid muscle, so as to give additional space. The external portions of the sterno-hyoid and sterno-thyroid muscles may likewise be cut across for the same purpose. The jugular vein in this situation lies considerably to the outside of the artery.

After ligature of the carotid artery, the blood is so freely conveyed to the distal side of the vessel, by the free communication subsisting between the arteries of opposite sides within the cranium, that a continuance and return of pulsation in the sac is of common occurrence. This condition, however, usually disappears after a time by the gradual consolidation of the tumor, and indeed may generally be looked upon as a favorable sign; being very seldom associated with those cerebral symptoms that, as will immediately be explained, commonly prove fatal after this operation. It is interesting to observe that the collateral supply, after the ligature of the common carotid, is not afforded by any of the branches of the corresponding vessel of the opposite side, but by the subclavian artery of the same side. In a case related by Porter, in which the right carotid had been tied, the subclavian and vertebral arteries on the same side were enlarged to at least double their natural diameters, and the chief communications outside the skull took place between the superior and inferior thyroid arteries, which were enlarged; whilst inside the cranium the vertebral took the place of the internal carotid.

Suppuration of the sac is not of very uncommon occurrence after the ligature of the carotid for aneurism—sometimes even after so considerable an interval as eight months, as happened in a case related by Post. In the majority of these instances the patient eventually does well; but death may result by the tumor pressing upon the pharynx and larynx, or by the occurrence of secondary hemorrhage, which may take place either from the part to which the ligature has been applied, or from the suppurated sac. In the first instance, it usually occurs about the period of the separation of the ligature; in the second, it may happen at a considerably later period, even after many weeks. Besides these, which may be looked upon as the ordinary accidents following the application of a ligature for aneurism, deligation of the carotid artery occasionally gives rise to serious and even fatal disturbance of the circulation within the cranium.

Effect on the brain of ligature of one or both carotids.—Many experiments have been made by Mayer, Jobert, and others, upon the lower animals, with the view of

derangement in the functions of the brain and med
induced by the disturbed state of the circulation through
we know that any cause which depresses the activity of the ner
es tends to diminish proportionately the freedom of the respiratory moveme
and thus, by interfering with the due performance of the act of respiration, disp
to congestion of the lungs, just as we observe to happen in injuries of the hea
apoplexy, and in the operation of the sedative poisons. It would appear from
detail of some of the recorded cases, as well as from Jobert's experiment,
bloodletting is of considerable service in the removal of this condition, and sho
consequently not be omitted.

Ligature of the Carotid on the Distal Side of the Sac.—Aneurism of
carotid artery, occurring low in the neck, does not admit of the application o
ligature on the cardiac side of the tumor. What, then, is to be done in such a c
as this? Should it be left to the remote chance of a spontaneous cure, or shoul
be subjected to surgical interference? Spontaneous cure in carotid aneurism
never yet, I believe, been met with. The surgeon, therefore, must endeavor to tr
the disease by ligature. Two plans of treatment are open to him—either to delig
the innominate artery, or to tie the carotid on the distal side of the tumor.
first alternative may fairly be set aside; for not only are the cases in which it
possible to find room between the sternum and the sac extremely rare, but, ev
were such an instance to present itself, no surgeon would, I think, be justified
undertaking an operation which has never yet succeeded in the most skilful hand
we are consequently reduced to the alternative of ligaturing the artery on the dist
side of the sac. But although this operation is the only alternative that presen
itself, yet its application in practice is attended by serious difficulties and perplex
ties; for the surgeon must be able to satisfy himself that it is actually an aneuris
of the root of the carotid with which he has to do, and that it is not the trunk
the innominata or the arch of the aorta that is affected. The difficulty in doing th
is far greater than would at first appear; for, on examining the details of eight case
in which the distal operation has been performed for supposed carotid aneurism

Aneurisms of Root of Carotid Treated by Ligature on Distal Side.

Operator.	Sex.	Age.	Result.	Cause of death.	Remarks.
1. Wardrop, 1826.	f.	63	Recovered.	.....	Tumor diminished until fifth day then inflamed, suppurated, and burst. The patient recovered, and was alive 3 years after operation.
2. Lambert, 1827.	f.	49	Successful so far as aneurism was concerned.	Hemorrhage from upper portion of artery.	Tumor diminished after operation and became consolidated; sac filled with firm coagulum, and lower part of artery closed; ulceration into artery, just above part ligatured; vessel dilated where ligatured.
3. Bush, 1827.	f.	36	Recovered.	.....	Suffocation was imminent before operation; tumor became rapidly diminished after ligature. Alive three years afterwards.
4. Montgomery, 1829.	m.	30	Died.	Sac suppurated.	Aneurism of arch also.
5. Colton de Noyou, 1840.	f.	63	Recovered.	.....	Tumor and pulsation diminished. Alive and well 3 years afterwards.
6. Demme, 1840.	m.	38	Died.	Suppurat'n of sac; hemorrhage.	Aneurism of arch; double aneurism of carotid.
7. Lane, 1852.	m.	63	Died 68th day.	Inflammation of lungs.	Tumor filled with layers of coagulum. Ulcerated opening communicating with apex of left lung.

three must be excluded; as, after death, the tumor was found to arise from the aortic arch. In the annexed table will be found the result of seven cases, in which the carotid artery has been tied for aneurism of its root on the distal side of the sac. I have excluded an eighth case, as there is reason to believe that in it the

[1] [The innominata has been successfully tied by Dr. A. W. Smyth, of New Orleans.—A.]

after the ligature of the vessel to allow the efficient deposition of lamellated coagulum, and consequent occlusion of the artery leading into it, which, in accordance with the principles that have been laid down in speaking of the Hunterian operation, are necessary to success.

INTRA-CRANIAL ANEURISM.

Aneurisms within the skull may arise from any of the arteries that are met with in this situation, though some are much more liable than others to the occurrence of this disease. Of 62 cases noticed by Gull, the basilar artery was the seat of disease in 20 cases, and the middle cerebral in 15. In 8 of the remaining cases, the internal carotid was affected as it lay by the sella Turcica; and in 6 others the anterior cerebral artery was the seat of aneurism. The vertebral arteries and their branches were affected in 28 cases, and the carotids and their branches in 34. The greater frequency of this disease in the basilar artery may probably be dependent on its large size, and the consequently greater impetus of the blood to it.

Causes.—The causes of intra-cranial aneurism are very obscure. It might be supposed that the comparatively small diameter of the arteries within the skull would render them little liable to the occurrence of spontaneous aneurism, were it not that the anatomical characters and physiological relations of these vessels predispose considerably to the occurrence of this affection; there being no other set of arteries in the body of the same size as these within the skull in which spontaneous aneurism so frequently occurs. This can only be accounted for by the thinness of their coats and want of an external cellular sheath rendering them unable to support the increased pressure from within, to which they are occasionally subjected in consequence of the alteration in pressure of cerebral circulation at different periods, the result of some variation in the relative quantities of the different fluids within the skull, or of determination of blood to the brain. This would more particularly be the case if their natural elasticity had already been impaired by the occurrence of atheromatous or other degeneration of their coats. As these changes are the natural consequences of advance in age, we shall find the tendency to the occurrence of this disease increase with advancing years. Thus, according to Gull, of 58 cases in which the patient's age is given, we find only 12 cases which occurred in persons under twenty-five, 5 of the patients being under twenty; of the remaining 46 cases, 13 occurred in persons under forty; of the remaining 33, 29 were met with between forty and sixty, and 4 in persons above sixty. Of the 58 cases, 35 were males, and 23 females.

Fig. 264.

Fusiform aneurism of basilar artery laid open.

The immediate exciting cause of the disease is most commonly involved in obscurity: sometimes it may be traced to a blow on the head, to a fall or concussion, or to excess in drinking; but more frequently the symptoms manifest themselves suddenly, without being in any way attributable to such external influences, and occur in vigorous and apparently healthy persons.

Pathology.—Intra-cranial aneurisms are almost always formed by the uniform dilatation of the whole of the calibre of the artery—the false or sacculated variety being rarely if ever met with; I am not acquainted with any instance of this. The coats of the arteries in this situation being very thin, and unprovided with any external cellular sheath that would support the impetus of the blood, rupture of the vessel would rather occur than partial dilatation, if one portion only of the circumference were diseased. Occasionally, though rarely, the dilatation is fusiform; when this does occur, it is probably confined to the basilar artery (Fig. 264).

The disease would appear to be of slow growth, and the sac sometimes becomes filled with lamellated coagula so completely as to occlude the orifice of the artery from which it springs.

The size that aneurism in this situation attains before death results is sometimes

considerable; thus, in a case of aneurism of the basilar artery, that occurred some years ago at the University College Hospital, the tumor was nearly as large as a walnut; in another case, in the same hospital, it somewhat exceeded this size. R. W. Smith, in the *Dublin Journal of Medical Science*, vol. xxv., mentions a case of multilocular aneurism of the left posterior cerebral artery as large as a small apple; and Serres, one as large as a hen's egg. On the other hand, they occasionally prove fatal by rupture before having reached more than a very small size—not larger than a pea or a nut.

It is seldom that more than one of the arteries of the brain suffer aneurismal dilatation. In the Museum of the College of Surgeons, however, are the preparations (Nos. 1687 and 1688) of aneurismal dilatation of both internal carotid arteries, resembling "two bulbs about five-eighths of an inch in diameter, filling up the hollow on each side the sella Turcica, which were evidently dilatations of the carotid arteries; and from their being filled with laminæ of coagulated blood, there could be little doubt of their being aneurisms of these arteries. The one on the left side was the largest; that on the right side communicated with the cavity of the artery, which was not the case with the other."

A case occurred in University College Hospital some years ago, under the care of Dr. Thomson, in which a somewhat similar condition existed. A man, forty-nine years of age, had fallen on his head some months before admission into the hospital. Since then he had been garrulous, silly, and very irritable—becoming readily intoxicated. He suddenly became insensible and comatose, with vomiting and laborious breathing; he could close both eyes, but the right pupil was dilated; the left side was paralyzed. He was treated for apoplexy, and became slightly better, but died in ten days from the first attack. On examination, an aneurism a little larger than a hazel-nut was found on the trunk of the right carotid, where it gave off the middle cerebral artery, and another small one on the course of that artery. There was a globular aneurism on the corresponding artery of the opposite side; the basilar artery was thickened, white, and opaque, as were also the other larger arteries of the brain; there was softening of both anterior cerebral lobes, especially the right one.

The arteries of the brain are very commonly healthy in these cases. Out of four instances of intra-cranial aneurism that have fallen under my observation, the other vessels of the brain have been healthy in three cases, and atheromatous in but one. In one case I have seen aneurism within the skull associated with aneurism elsewhere —in the thoracic aorta.

Pressure-Effects.—The pressure exercised by an aneurismal sac situated within the skull is always exclusively directed against the yielding cerebral substance, which is often extensively disorganized. The bones of the skull, however close their proximity to the sac may be, frequently escape, and seldom suffer much. This peculiarity in the effects of aneurism in this situation may be partly owing to the very dense and compact character of the inner layer of the skull, but is doubtless principally due to the very soft and yielding nature of the contents of the cavity. Absorption of the subjacent bone, however, sometimes takes place to a limited extent; thus in one case (Moore's) the body of the sphenoid bone was indented and partially absorbed.

The parts compressed in each case will vary according to the situation of the tumor. But those that principally suffer are necessarily those seated at the base of the brain, and forming the floor of the lateral ventricles. In Moore's case, one of the optic nerves was flattened by the pressure of the substance of the anterior lobe; the lamina perforata, the roots of the olfactory tract, the anterior part of the corpus striatum, and a considerable quantity of the neighboring white matter of the anterior lobe, were removed. In a case by Lager, the portio dura of the right side was paralyzed from this cause. In R. W. Smith's case, the floor of the third ventricle, the tuber cinereum, and the origins of the optic and olfactory nerves suffered; the optic nerve of the opposite side was flattened and softened.

Besides the changes that take place in the cerebral substance as the result of pressure, important lesions may be met with as the effect of the interruption which the presence of the aneurism offers to the circulation in and nutrition of the cerebral hemispheres. Thus, in the case of aneurism of both internal carotids that has already been referred to as occurring at University College Hospital, there was white softening of both the anterior cerebral lobes; and this lesion was most marked

on the side that corresponded to the largest aneurism, and where, consequently, it may be supposed, the greatest amount of obstruction to the circulation existed.

Symptoms.—The symptoms of aneurism within the skull are extremely equivocal; and, indeed, aneurism of large size may exist at the base of the brain without occasioning any symptoms whatever. An interesting instance of this occurred at University College Hospital in 1848. A man, thirty-seven years of age, died of pulmonary apoplexy and chronic pneumonia of the left lung, consequent upon the pressure of an aneurism of the commencement of the descending aorta on the pulmonary veins of that side. In examining the head after death, an aneurism of the basilar artery as large as a hazel-nut was met with, of which no suspicion had been entertained during life, there having been no head-symptoms whatever; the sac of the aneurism was very thin, and there was much atheromatous degeneration in the vertebral arteries.

The only symptoms that are of constant occurrence, when this disease goes on to a fatal termination, are those of hemiplegia and apoplexy. These may come on suddenly without any previous warning; or they may be preceded by a train of phenomena indicative of the existence of chronic disease within the cranial cavity.

The most constant of these phenomena is pain; which affects, however, great variety, both in extent and in character. It may be diffused, or may occupy a fixed point; it may be continuous or intermitting; it may be increased by movement, or accompanied by peculiar sensations, as of pulsation or of opening and shutting the top of the cranium.

The sight and hearing are often impaired. Dimness of sight, dilatation of one or both pupils, photophobia, diplopia, and loss of vision have been noticed in several of the cases recorded; ptosis has also been met with, from pressure on the third nerve by aneurism of the posterior communicating artery. Buzzing noises in the ears, and deafness, are also not uncommon symptoms; deafness, more particularly, appears to be a phenomenon of frequent occurrence.

The patient rarely loses the power of articulation and of deglutition; impairment of these functions, however, has been met with.

There may be paralysis of the side of the face, shaking palsy, or complete hemiplegia; or fits of an epileptic nature may occur. The mental condition may undergo changes indicative of chronic disease of the brain. There may be depression of spirits, listlessness, or, as was noticed in the case above related, the temper may become irritable, and the patient be garrulous or silly. Insanity has been noticed in one case. As is always the case in cerebral affections, the gastric functions are often impaired.

But very frequently no premonitory symptoms manifest themselves; the patient being suddenly seized, when apparently in good health, with apoplexy, which terminates rapidly in death.

In some cases the presence of aneurism has been detected by a loud rough or "whizzing" noise being heard on the application of a stethoscope over one side of the head, and, perhaps, being audible to the patient. This sign, however, exists in but few cases; but when it does occur, it is unquestionably the most pathognomonic of all. I am not aware that it has been met with in any form of cerebral disease except intra-cranial aneurism.

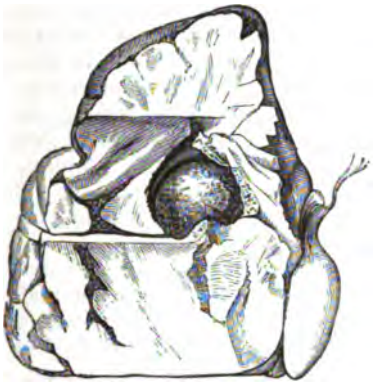
Thus it will be seen by a reference to this list of symptoms that, with the exception of the whizzing noise, no special signs are afforded by aneurisms within the skull, which will enable us to distinguish between the symptoms occasioned by their presence and those of other tumors of the brain, and of organic cerebral disease.

Causes of Death.—The fatal termination may occur from one of four causes.

1. The tumor may exercise such *pressure upon the whole cerebral mass* as to occasion death. This mode of termination is rare. I am acquainted with but one case of this description, which is reported by Ruschenberger. The symptoms in this case were very remarkable, consisting of complete hemiplegia of the left side, with involuntary antero-posterior vibration of the head and body, and paralysis agitans of the right leg. The patient slept heavily, with loud snoring; he ate voraciously, but occasionally had considerable difficulty in deglutition and articulation; his intellect was clear, but very slow. After death, an aneurism of the basilar artery as large as a pigeon's egg, and containing an irregular very hard dry clot of blood, was found pressing on the pons Varolii. The sac had given way at one point, extravasation taking place into the substance of the pons, which was softened, and of a bluish color.

2. The most frequent mode in which death takes place in these cases is by the *sudden rupture of the sac* and the extravasation of its contents into the cavity of the arachnoid and the meshes of the pia mater at the base of the brain, or into the lateral ventricles—either from the aneurism projecting into them and there giving way, or rupturing into these cavities by breaking down the intervening cerebral substance (Figs. 265, 266). When this mode of termination occurs, there are occasionally no warning nor premonitory symptoms of any impending danger; the patient being, apparently in good health, struck down by an attack of apoplexy which is speedily fatal.

Fig. 265.



Aneurism of the left internal carotid, bursting into lateral ventricle. View of aneurism from above, projecting into ventricle.

Fig. 266.

View of the same aneurism from below, imbedded in substance of hemisphere.

More frequently a series of those symptoms that have already been mentioned as attending many cases of this disease, precede the fatal event for a longer or shorter time. When rupture of the sac and extravasation of blood take place, death is inevitable; at least I am not acquainted with any case in which the appearance found after death converted me to the belief that the patient had even temporarily recovered from this condition.

Death from rupture of the sac appears to be most frequent in younger subjects. In the later periods of life, aneurism is commonly associated with atheromatous disease of the vessels generally, which may cause death by softening and effusion of blood. According to Gull, of 20 cases occurring in persons under thirty-five years of age, 16 (or 80 per cent.) were fatal from rupture of the sac; while in 37 cases over thirty-five, death occurred from this cause in only 14, or 38 per cent.

3. Death may result from another cause than the pressure of the aneurismal sac or its rupture and the extravasation of its contents—viz., from *softening or disorganization of the substance of the brain* to a greater or less extent, in consequence of the obstruction offered to the passage of the blood through the aneurismal vessel. In the case of aneurism of both carotids, already mentioned as having occurred at University College Hospital, this was the case; both anterior cerebral lobes were affected with white softening, and this condition was especially observable on that side on which the aneurism was largest.

4. Lastly, death may be produced by the mere *irritation* occasioned by the pressure of one or more aneurismal tumors within the cranium. Of this an interesting example is afforded by the history of a case of aneurism of both external carotids, contained in the Museum of the College of Surgeons, and related by Sir G. Blane in the *Transactions of the Society for the Improvement of Medical and Chirurgical Knowledge*, vol. ii. p. 192. In this case the patient, a lady aged 69, had suffered for four years from attacks of giddiness, headache, and imperfect vision; about sixteen months before her death she became insane, recovered, and then relapsed twice in the same state. After having regained her senses for some months, she became affected with giddiness, redness of the eyes, and violent maniacal delirium, which continuing for some weeks caused her death.

After death the following appearances were found. "Upon examining the body,

there was no appearance in the brain itself that could in any way account for the symptoms. There was, indeed, a greater quantity of fluid than common in the ventricles, and the surface of it was moister than it is usually found in a sound state; but in all other cases which have occurred to me of organic affections of the brain proving fatal, except those which are sudden, such as apoplexy, there has been a preternatural quantity of fluid in its ventricles. There were also spicula of bone in the membrane forming the falx. The inner substance of the crura cerebri was of a brown color, and more tender than natural. The optic nerves were smaller than natural, as if they had been wasted. The septum lucidum was more than usually dense.

"But the morbid appearance in this case, which was so singular, and to which the symptoms of complaint seem chiefly referable, was two bulbs, about five-eighths of an inch in diameter, filling up the hollow on each side of the sella Turcica, which were evidently dilatations of the carotid arteries, and, from their being filled with laminæ of coagulated blood, there could be no doubt of their being aneurisms of these arteries. The dissection was made by Mr. Hunter, assisted by Mr. Home, in the presence of Dr. Jenner and myself, and all concurred in the opinion that these tumors were aneurisms. The one on the left side was the largest. That on the right side communicated with the cavity of the artery, which was not the case with the other."

Treatment.—In the treatment of intra-cranial aneurism there is usually little to be done, the nature of the case not being sufficiently obvious in the majority of instances to justify active measures. Should, however, the loud rough whiz be distinctly audible over one side of the head, more especially about the base of the skull, or by application of the stethoscope to the mastoid process, and should symptoms of cerebral compression begin to manifest themselves, ligature of the carotid artery on the affected side may with propriety be practised. This has been successfully done in a most interesting and instructive case of intra-cranial aneurism by Coe of Bristol; and in one at University College Hospital, by Berkeley Hill.

[The best account of intra-cranial aneurisms which has been published in this country, is by Dr. James H. Hutchinson of this city, who has collected and analyzed no less than 85 cases. (*Penna. Hosp. Reports*, vol. ii. pp. 83–107.)—A.]

INTRA-ORBITAL ANEURISM.

Intra-orbital aneurisms were for a long time considered by surgeons to be of the nature of erectile tumors; but the error of this opinion has been pointed out by Busk, and more recently by Nunneley, who has conclusively shown that, except in those very rare cases in which a pulsating tumor of the orbit has been congenital, or has appeared shortly after birth, or has been associated with nævoid tissue developed in the eyelids, it must be looked upon as being a circumscribed aneurism. The vessel affected appears to be in some instances the ophthalmic artery itself; in other instances it would appear that the tumor is developed within the cranium, springing from the carotid artery, the ophthalmic being but secondarily affected.

Causes.—The causes of intra-orbital aneurism are in some cases very obscure; in others, it evidently and directly has originated from a blow upon the head. In the first class of cases, where the disease has been of spontaneous and not of traumatic origin, the patient has suddenly felt a crack or snap in the orbit, like the "crack of a whip," or the "snap of a gun," and the disease has then developed itself gradually. In the other or traumatic cases, the blow upon the head has usually been severe, attended in some instances with symptoms of fracture of the anterior part of the base of the skull. It is a remarkable circumstance that, in all the spontaneous cases on record, the disease occurred in women, and with one exception (a case of Nunneley's), appeared on the left side. [To this exception must be added another, in the case of a patient successfully operated upon by Dr. Thos. G. Morton of this city, at the Pennsylvania Hospital. (*Am. Journ. Med. Sciences*, April, 1865, p. 318, and *Penna. Hosp. Reports*, vol. i. p. 200.)—A.] The circumscribed intra-orbital aneurism has been met with at all ages in adults, even in persons of advanced periods of life.

Symptoms.—The first sensation experienced is, in spontaneous cases, that of a loud snap or crack in the orbit or head. This is followed by congestion of the conjunctiva, difficulty in opening the eyelids, a feeling of tension, and in some instances

severe pain in and around the orbit. Loud whizzing bewildering noises are experienced in the head, and are much increased on stooping or lying down. In traumatic cases, a persistence of congestion of the conjunctiva, with redness and some œdema of the eyelids, and the occurrence of noises in the head, are usually the first indications of the mischief that has occurred. In all cases, after a time, the eyeball becomes unduly prominent, and pulsation of a thrilling vibratory character can be felt in the orbit: on the application of the ear, a loud whizzing bruit is discernible, which extends widely over the side of the head. The eyeball itself eventually falls into a state of chronic congestion; chemosis occurs, the cornea becomes opalescent, the aqueous humor turbid, and sight is impaired or lost. The bruit and pulsation are diminished or cease on compressing the carotid artery of the side affected.

Prognosis.—I think it is still doubtful what would happen in these cases, if the disease were left to itself without operation. It might be supposed that it would probably have a fatal termination; that the orbital plate would be perforated; that rupture of the aneurism would take place into the cranial cavity, and that sudden and immediate death would occur. But experience has shown that this is not necessarily so. I was consulted at the end of 1865 by a gentleman about 44 years of age, who, in consequence of a fall on the head a few months previously, had been attacked with symptoms of aneurism of the left orbit in the most marked manner. The bruit and the pulsation were very loud and distinct. The eyeball was greatly protruded, the conjunctiva and eyelids were congested and swollen. Mr. Greaves, of Burton, with whom I saw the case, agreed with me in urging ligature of the carotid artery as the only means of cure. To this the patient would not consent, and preferred taking his chance. By attention to habits of life, abstinence from stimulants, and ordinary medical treatment, the tumor subsided, the eye retreated within the orbit, and the symptoms subsided greatly; so that, at the end of fourteen months from the time that I first saw him, I understand that they had to a very great extent disappeared.

But there is reason to believe that all the signs of intra-orbital aneurism may entirely disappear, the disease undergoing a spontaneous cure. Collard relates the case of a man 41 years of age, who, in consequence of a fall on the back of his head by which he was rendered insensible, was gradually seized with symptoms of aneurism of the left orbit; bruit, pulsation, diplopia, and protrusion of the eyeball, together with congestion of the eyelids, being most marked. After the disease had continued for a considerable length of time, the patient was put upon a course of purgatives, with a calomel and belladonna pill daily, and cold lotions to the forehead. Under this treatment the symptoms gradually subsided, and in three years and a half from the commencement of the disease, had entirely disappeared. Collard believes that in this case there was a dilatation of the ophthalmic artery and its branches, arising from and maintained by a morbid state of the ophthalmic ganglion, which furnishes vaso-motor filaments to the arteries of the eye. This ganglion he believes to have been injured by *contre-coup*, and to have remained in a state of hyperæsthesia, which produced dilatation of the walls of the ophthalmic artery and its branches, increase and acceleration of the pulsations, and the other symptoms which have been described above.

Pathology.—The precise pathological change that takes place in inducing this remarkable disease is to a very considerable degree uncertain. The earlier observers supposed that an erectile tumor, an "aneurism by anastomosis," formed in the orbit. The fallacy of this opinion was pointed out by Busk, who referred the symptoms to a rupture of the ophthalmic artery and the development of a circumscribed traumatic aneurism of that vessel. More recently Nunneley has called in question the correctness of this view of these cases, and has referred the symptoms to a peculiar vascular condition of the parts, dependent more upon an affection of the veins than of the arteries, and somewhat analogous to what takes place in the exophthalmos of bronchocele. Pathological anatomy has as yet thrown little light on the true nature of the disease. In one instance in which the patient died after the ligature of the common carotid artery in a case which presented all the phenomena of intra-orbital aneurism in the most marked degree, and which was recognized as such by some of the most able oculists of the day, no trace of aneurism or of other vascular disease could be found on dissection. Is it possible that some derangement of the vaso-motric influence of the sympathetic may really occasion the symptoms of increased vascular activity that are so characteristic of this singular disease?

The secondary phenomena that are observed in these cases, such as congestion of

the eyelids, of the palpebral and ocular conjunctivæ, amounting even to chemosis in many cases, and the muddiness of the aqueous humor and lens, are doubtless due to an interference with the return of blood from these parts through the ophthalmic vein, to the consequent congestion of the smaller vessels, and to effusion of serum into the subconjunctival areolar tissue. The protrusion of the eyeball is due to the vascular tumor, whatever its precise nature may be, and the derangement in vision to an alteration in the axis of the eye consequent on this extrusion. It is remarkable that the *bruit* in these cases should be so loud, not only to the patient's own senses, but to the ear of the surgeon; and this can only be accounted for by some acoustic exaggeration of the sound, dependent either on the thin and flaccid sides of the vessels through which the blood rushes, or on the proximity of the cranial bones, which may act as conductors of sound.

Treatment.—The result of the cases that have been referred to above, the uncertainty in which we are as to the real pathology of this disease, and the certainty that in some instances at least there is no true aneurismal tumor, would justify the surgeon in having recourse to medical treatment, aided by digital compression of the carotid, and, perhaps, the application of ice to the forehead, before proceeding to operate. Should these means fail in producing a decided impression on the disease, then the only means left for the successful treatment of this formidable disease consists in the application of a ligature to the common carotid of the side affected. This operation has been highly successful. Out of 21 cases in which the operation has been performed, 15 have proved successful, there having been 3 deaths; 2 were only partially successful, and in 1 the pulsation continued unabated by the operation. Of 14 cases in which it has been done in England, 13 have been cured. Examination of the body after death is recorded in two of the fatal cases. In one, there was softening of the left hemisphere of the brain, and the branches of the vertebral and carotid arteries were atheromatous. In the other —a case of traumatic aneurism—death occurred from hemorrhage; the carotid artery was healthy. In a very interesting case which I saw in Velpeau's wards in 1839, both orbits were affected; and, as pressure on the right carotid arrested the pulsation and bruit in both, that artery was tied. But though the disease was cured in the left orbit by this operation, and temporarily arrested in the right, it reappeared in the latter situation, and was eventually cured here by the ligature of the left carotid.

ANEURISM OF THE SUBCLAVIAN ARTERY.

Aneurisms of the subclavian occur in order of frequency between those of the carotid and of the brachio-cephalic arteries. They are most frequently met with on the right side, in the proportion of nearly three to one; and this would appear to be in a great measure dependent on their being occasioned by direct violence, or by repeated or prolonged exertion of the arm; thus they commonly occur from falls, blows upon the shoulder, or excessive fatigue of this extremity. From the fact of the aneurisms arising from external violence, we should expect to meet with them most frequently in males, and this we do in a remarkable manner. Of thirty-two cases, I find only two occurring in females, and in both these instances the disease resulted from injury. The disease may be seated in any part of the vessel on the right side, though most commonly it is not dilated until after it has passed beyond the scaleni. On the left side, aneurism never occurs before the artery has emerged from the thorax; and then, as on the right, it most commonly happens in the third part of the course of the vessel.

Symptoms.—An aneurism of the subclavian artery is characterized by a pulsating compressible tumor of an elongated or ovoid shape, situated at the base of the posterior inferior triangle of the neck, immediately above the clavicle. If it be small, it will disappear behind this bone on the shoulder being raised; as it increases in size, it fills up the whole of the space between the clavicle and the trapezius, often attaining a very considerable bulk. In consequence of the pressure which it exercises on the brachial plexus of nerves there is pain, often attended by numbness, and extending down the arm and fingers, usually with some weakness of these parts. In some instances there is a spasmodic affection of the diaphragm, owing to irritation of the phrenic nerve. The external jugular vein is commonly distended and varicose, with œdema of the hand and arm, or even of the side of the

body. The tumor does not increase rapidly in size, owing to its being tightly compressed by the surrounding parts; and, as the disease never extends inwards, it does not interfere with the trachea or œsophagus. In some cases it has been known to extend downwards and backwards, so as to implicate the pleura and the summit of the lung.

Diagnosis.—The diagnosis of these aneurisms is usually easy, and presents no point of a special character.

Results.—As subclavian aneurisms increase in size, they may become diffused, and burst either externally or into the pleural sac. In some instances a spontaneous cure has been observed.

Treatment.—The treatment of subclavian aneurism is in the highest degree unsatisfactory. The attempts at obtaining consolidation of the tumor by *constitutional means*, by *galvano-puncture*, or *compression*, have hitherto failed, except in some very rare instances. A case is reported by Yeatman of the cure of subclavian aneurism by Valsalva's plan in eighteen months; and another by Abeille, in which the tumor was consolidated by galvano-puncture. *Manipulation*, as recommended by Fergusson, has succeeded in the hands of Little, and undoubtedly deserves a trial in these cases, when we consider the extreme danger and almost universal want of success that attend other means of cure.

Ligature of the brachio-cephalic, and of the subclavian itself, before, between, and beyond the scaleni muscles, has been practised for the cure of this form of aneurism; it has likewise been proposed to apply the distal operation to the treatment of this disease, and to amputate at the shoulder-joint.

When an aneurism is situated on the right subclavian artery on the tracheal side of the scaleni, there is no way in which the flow of blood through it can be arrested, except by the ligature of the brachio-cephalic artery. When it is situated beyond the scaleni, or even between these muscles, the ligature of the vessel has been practised in the first part of its course before it reaches these muscles. For subclavian aneurisms on the left side, in these situations, no operation conducted on the Hunterian principle would be practicable.

Let us now proceed to examine the results that have attended these operative procedures.

Ligature of the Brachio-Cephalic.—The brachio-cephalic artery, as may be seen by the accompanying table (p. 646), has been ligatured thirteen times, and in every instance but one with a fatal result. In four other instances the operation has been commenced, but abandoned owing to unforeseen difficulties, and this by some of the most skilful operators that their respective countries can boast of.

Although, in reasoning on the propriety of performing an operation, it is not in general worth while to take into consideration the difficulties that a surgeon may encounter, provided the operation be at last practicable; yet, when we consider the fact of the ligature of the brachio-cephalic having been attempted, and in consequence of unforeseen and insurmountable difficulties left unconcluded in so large a proportion as one-fourth of the cases, and these in the hands of surgeons who were as well able as any to accomplish whatever was in the power of operative surgery to do, we may well hesitate upon the difficulties that beset the operation itself, before proceeding to the consideration of its results. The difficulties to which I allude do not consist merely in the position and anatomical relations of the vessel, but rather in the condition in which the artery and the adjacent structures may be found after the vessel is exposed. Thus, in Porter's case, the aneurism, which was a large one, occupied the whole of the inferior posterior triangle of the neck, being nearly six inches broad; as no pulsation was traceable in the vessels beyond the aneurism, it was useless to attempt ligature on the distal side. On exposing the brachio-cephalic, that vessel was found to be diseased, and it was not thought desirable to pass the ligature round it. In consequence of the exposure of the artery, however, the pulsation in the tumor gradually diminished, and at last ceased entirely, its bulk also becoming less.

In Key's case, in which it was impracticable to pass the ligature, it was found after death that the brachio-cephalic was diseased, being dilated immediately after its origin into an oblong tumor, which occupied the whole of the artery. It is remarkable that in this case, as in Porter's, inflammation seems to have taken place in the artery in consequence of the necessary handling to which it was subjected, and that the pulsation in the sac consequently diminished.

The difficulties of the operation are in themselves of serious magnitude; arising from the depth of the vessel, from its proximity to the centre of the circulation, and from the neighborhood of large veins, which may become turgid, and a wound of which not only obscures the line of incision with venous blood, but induces a risk of the entrance of air into the circulation. But even when these have been surmounted, and the artery has been exposed, its coats may be found so diseased, or its calibre so increased, that it may be undesirable or impossible to pass a ligature round it. The failure in deligating the artery would, however, as we shall immediately see, appear to be less disastrous in its consequences than success in that attempt; for of the three cases that have just been referred to, in which this attempt was made and did not succeed, one was cured of the disease, the artery being obliterated by adhesive inflammation; and in another, Key's patient, an attempt to

Cases of Ligature of Brachio-Cephalic Artery.[1]

Operator.	Sex.	Age.	Nature of disease.	Result.	Remarks.
1. Mott,	m.	57	Subclavian aneurism.	Died on 26th day.	Tied an inch below bifurcation. Ligature separated in fourteen days. Hemorrhage on 25th day, stopped by pressure; recurred on 26th.
2. Gräfe,	...	...	Subclavian aneurism.	Died on 67th day.	Ligature separated in fourteen days. Died of hemorrhage.
3. Hall,	...	...	Subclavian aneurism.	Died on 5th day.	Artery was diseased and gave way. Bleeding arrested by plug; death from other causes.
4. Dupuytren,	...	...	.....	Died.	Case referred to as occurring in the practice of Dupuytren.
5. Norman,	m.	...	Subclavian aneurism.	Died.	Died of pericarditis sixty hours after operation.
6. Bland,	m.	31	Subclavian aneurism.	Died on 18th day.	Hemorrhage came on on the 17th and 18th days. Ligature applied to upper portion of artery.
7. Lizars,	...	...	Subclavian aneurism.	Died on 21st day.	Ligature separated on 17th day. Hemorrhage on 19th.
8. Hutin,	m.	26	Hemorrhage from axilla after ligature of subclavian.	Died in 12 hours.	Punctured wound in axilla, for which subclavian was tied; secondary hemorrhage, and then brachio-cephalic tied.
9. Arendt,	...	...	Subclavian aneurism.	Died on 8th day.	Inflammation of lung, pleura, and aneurismal sac.
10. Cooper, (San Francisco.)	m.	...	Subclavian and carotid aneurism.	Died on 9th day.	Upper end of sternum and inner end of clavicle removed. Dyspnœa and retention of urine; pus in the right kidney.
11. Cooper, (Do.)	m.	...	Subclavian and carotid aneurism.	Died on 34th day.	Bones removed as in previous case. Patient was apparently doing well, when secondary hemorrhage appeared. Immediate cause of death, hemorrhage, in consequence of removal of bandages by patient.
12. Gore, (Bath.)	m.	52	Subclavian and axillary aneurism.	Died on 17th day.	Artery cut through by ligature. Carotid extremity not contracted, but partially plugged with dark coagulum. Inflammation of subclavian vein (left). Pus in anterior mediastinum. Aneurism contracted and filled with coagulum.
13. Smyth, (New Orleans.)	m.	...	Subclavian aneurism.	Recovery.	Ligature applied to brachio-cephalic a quarter of an inch below bifurcation, and at same time to carotid one inch above origin. Hemorrhage on 15th, 33d, and 51st days. Ligature of right vertebral on 54th day.

N. B.—The artery was cut down upon, but not actually ligatured, by Porter, Post, Aston Key, and Hoffman.

[1] These are all the cases of ligature of the brachio-cephalic artery the details of which I have been able to collect. This artery is also said to have been once ligatured by Pirogoff, and twice by Bugalski—all three cases fatal; but, as I can find no details of these operations, I have omitted them in the above table. Gurlt, in his report on Surgery (*Archiv fur Klinische Chirurgie*, vol. iii., 1862), says, in speaking of Cooper's second case: "This is the *fifteenth* case of ligature of the innominate artery; and every one of them has proved fatal."

therefore the surgeon's sole resource in the treatment of these cases. The part of the vessel universally selected for the application of the ligature is, in accordance with the Hunterian doctrines, that which lies on the first rib beyond the scalenus anticus muscle; this part presenting the advantages of being sufficiently removed from the seat of disease to insure the probability of the coats of the artery being in a sound state, of being by far the most accessible, and, when deligated, of allowing the collateral circulation by which the vitality of the arm is to be maintained to remain uninjured. Notwithstanding these obvious advantages presented by the ligature of the subclavian over that of the axillary artery, in other words, by performing Hunter's instead of Anel's operation for the cure of spontaneous axillary aneurism, there would appear to be a tendency in the minds of some surgeons to advocate the latter instead of the former of these operations; and to substitute for one that offers the advantages that have just been mentioned a procedure that is not only much more difficult in its performance, and that interferes with the collateral circulation, but that is practised upon a diseased part of the vessel, in dangerous proximity to the sac.

Ligature of the Subclavian in the Third Part of its Course.—In order to apply a ligature to that portion of the subclavian artery which intervenes between the acromial edge of the scalenus anticus and the lower border of the first rib, the patient should be placed in the recumbent position, the arm depressed as much as possible, and the head turned somewhat to the opposite side. The integuments of the lower part of the neck should then be put on the stretch by being drawn downwards over the clavicle, and an incision about four inches in length made upon the bone through the integument, the superficial fascia, and the platysma. When tension is taken off the part, this incision will be found to traverse the base of the inferior triangle of the neck; a vertical incision should then be made at right angles to, and falling into the centre of, the first, and the two flaps of integument and fascia should then be turned up. A quantity of loose areolar tissue will now be exposed, in which a venous plexus and the lower end of the external jugular vein will commonly be found. These vessels should be carefully avoided, and the areolar tissue dissected or scratched through with the point of a knife and a blunt probe; should any vein be wounded, a double ligature must be passed underneath it, or either end tied. If the transversalis colli or humeri arteries, as occasionally happens, should inconveniently traverse this place, they must be drawn out of the way with a blunt hook. By the combined action of cutting and scratching through the arelor tissue, the external edge of the scalenus anticus is reached; this is the "directing line" down which the finger is run until the tubercle of the first rib is felt. This is the guide to the artery, which will be found immediately above and a little behind it, covered, however, and bound down to the rib by a dense fascia. This must now be very carefully opened with the edge of the knife, and the needle passed from before backwards. In doing this, attention must be paid to the brachial plexus, situated above and behind the artery.

There are several points in connection with this operation that deserve special attention. In the first place, it is necessary that the shoulder should be depressed as far as possible, so as to bring the superior margin of the clavicle down. This is a matter of much importance; for, if the clavicle be thrust upwards by the pressure of a large aneurism, the surgeon will have to find the artery at the bottom of a deep narrow wound, instead of on a comparatively plain surface. A case occurred to Sir A. Cooper, in which the attempt to ligature the subclavian artery for a large aneurism of the axilla was forced to be abandoned, in consequence of the clavicle being thrust up to too great a height to enable him to reach the vessel. The extent of the difficulty occasioned by this elevation of the clavicle must necessarily depend in a great measure upon the height at which the subclavian artery happens in any particular case to be situated in the neck. It is not uncommon to find it pulsating so high in the neck, that no amount of elevation of the clavicle by subjacent axillary aneurism could raise that bone above the level of the vessel. In the majority of cases, however (in seventeen out of twenty-five, as shown by Quain in his work on the *Arteries*), it is either below the level of the bone, or but slightly raised above it; so that, if the clavicle were thrust upwards and forwards, the vessel would be buried in a deep pit behind it. Dupuytren was of opinion that the artery coursed high in persons who were thin, with slender long necks; whereas, in thick, short-necked

persons, with muscular shoulders, it was deeply seated. I have often verified the truth of this observation, both in dissection and in examining the pulsation of the vessel during life.

In order to obviate the difficulty that has occasionally been experienced in reaching the artery when thus buried behind an elevated clavicle, it has been proposed by Hargrave to saw through the bone. The most serious objection that can be raised against this practice is the fact of the clavicle being sometimes a part of the wall of the aneurism; but, supposing the surgeon could satisfy himself that this was not the case, I cannot see any objection to this procedure, provided any very great and insurmountable difficulty presented itself in getting the ligature round the vessel without it.

In passing the needle round the subclavian, care must be taken that some of the lower cords of the brachial plexus be not included in the noose; and indeed the mistake has more than once been committed of tying these nervous trunks instead of the vessel. Thus, Liston, in the first successful case of ligature of the subclavian in this country, passed the thread round the lower nervous cord; but immediately perceiving his error, turned it to account by drawing aside the included nerve, and thus more readily exposing the artery. Dupuytren, in a case of aneurism of some years' duration, succeeded, after an operation that lasted one hour and forty-eight minutes, and which he describes as the most tedious and difficult he ever attempted, in passing a ligature round the vessel, as he believed. After the death of the patient, which occurred from hemorrhage on the fourth or fifth day, the fourth cervical nerve alone was found included in the noose. In a case related by Porter, it is stated that the artery communicated such distinct pulsation to the inferior nervous trunk, that there were no means of ascertaining whether it was the vessel or not, except by passing the needle under it.

In some cases, as has already been stated, the sac passes upwards below the clavicle into the inferior posterior triangle of the neck; when this is the case, the surgeon incurs the risk of puncturing it from its close proximity to the artery, as it lies on the first rib. This accident happened to Cusack while ligaturing the subclavian in the third part of its course, for a diffused aneurism of the axillary artery. An alarming gush of blood took place, which was arrested by plugging the wound; but the hemorrhage recurred on the tenth day, and the patient died. In a case related by Travers, in which the sac was punctured by the needle, which was being passed round the artery, the blood, which was arterial, did not flow *per saltum*, but in a continuous stream. "The hemorrhage," Travers says, "was more terrific and uncontrollable than I have ever witnessed," and was not commanded by drawing the ligature tight. It was so great that it was doubtful whether the patient would leave the theatre alive, and was only arrested by plugging the wound with sponge-tents. The patient died of inflammation of the pleura. On examination, the aneurismal sac was found to have a pouch-like enlargement upwards, overlying the artery, where it had been punctured.

Ligature between the Scaleni.—If the sac encroach upon the neck, rising above the clavicle, or the artery be not sound in the third part of its course, it may be necessary to ligature it between the scaleni, dividing the outer half or two-thirds of the scalenus anticus. This operation should not be considered as distinct from ligature of the vessel in the third part of its course, but rather as an extension of that proceeding, if it be found, for the reasons just mentioned, unadvisable to tie the artery on the first rib; in this way it has been practised by Dupuytren and Liston. In its first steps, as far as the exposure of the scalenus anticus, it is the same as that for the deligation of the vessel in the third part of its course. When this muscle has been exposed, a director must be pushed under it, upon which it is to be divided to the extent of half or two-thirds its breadth, when it retracts, exposing the vessel. During this part of the operation, some danger may be incurred to the phrenic nerve, and to the transversales colli and humeri arteries; but if ordinary care be taken, this will not be very great. The phrenic nerve, as I have found by very frequent examinations on the dead body, lies altogether to the tracheal side of the incision, if that be not carried beyond one-half the breadth of the muscle; and should it appear to be in the way, it may readily be pushed inwards towards the mesial line, being only loosely invested by areolar tissue. I have, however, seen one instance in which the right subclavian artery was ligatured for a spontaneous cylindriform aneurism of the axilla, and the patient died on the eighth day, of

pneumonia; on examination after death, the edge of the scalenus was found cut, and the phrenic nerve divided. Had the injury to the nerve in this case anything to do with the pneumonia? I do not think it improbable; as division of one phrenic nerve, by paralyzing to a certain extent the diaphragm, and so far interfering with the respiratory movements, must necessarily have a tendency to induce congestion of the lung, which would readily run on to inflammation of that organ. I have likewise heard of one case in which incessant hiccough followed this operation, and after death the phrenic nerve was found reddened and inflamed, having probably in some way been interfered with during the exposure of the vessel.

Another important point in reference to the ligature of the vessel in this part of its course, is the frequency with which a branch arises from the subclavian artery between the scaleni. When this peculiarity exists, there would probably be but a slender chance of the occlusion of the artery by ligature in this situation. The transversales colli and humeri arteries, though in some danger, whilst crossing over the scalenus anticus, may be avoided by keeping the incision in the muscle between and parallel to these vessels. One principal danger in ligaturing the subclavian artery at any point above the fifth rib, certainly arises from interference with the fine areolar tissue which lies between it and the scalenus muscles, separating it from the pleura, and which is continuous with the areolar membrane of the anterior mediastinum, being indeed the deep portion of the ascending layer of what Sir A. Cooper has described as the "thoracic fascia," and which tends to form the superior boundary of the chest, being continuous in the neck with the deep cervical fascia. After the deeper layers of the cervical fascia have been opened, this fine areolar membrane presents itself; and, if inflammation be excited in it, the morbid action will readily extend by mere continuity of tissue into the thorax by the anterior mediastinum, invading ultimately the pleura and pericardium. Hence, whenever it is practicable, the surgeon should keep the point of the needle close to that part of the artery which lies upon the first rib, as there is less risk here of opening into the deep areolar tissue of the neck.

Accidents following Ligature of the Subclavian.—The general result of the ligature of the subclavian artery in the third part of its course, for spontaneous aneurism in the axilla, is by no means satisfactory. Thus, of forty-eight cases of aneurism of the axillary artery, not dependent upon any external wound, in which the artery was ligatured above the clavicle, I find twenty three cures against twenty-five deaths. This result is so unfavorable, and so different, indeed, from what I anticipated, that I have been led to analyze carefully the causes of death. I find them as follows:—

Inflammation within the chest, &c.	10	cases.
Suppuration of the sac	6	"
Suppurative phlebitis	1	"
Hemorrhage	3	"
Gangrene of hand and arm	1	"
General gangrene	1	"
Not stated	3	"
	25	"

Thus it will be seen that the two most frequent causes of a fatal result following the operation for axillary aneurism, are not those that are usually met with after the ligature of the larger vessels. It would therefore appear to be owing to some special condition, dependent either upon the application of a ligature to the subclavian artery in the third part of its course, or upon the situation and nature of the disease for which that operation is had recourse to; and the important point to be determined is, whether these conditions are the accidental or the necessary consequences of the application of a ligature in this situation for the cure of aneurism in the axilla.

Inflammation of the contents of the thorax proved fatal in 10 out of 25 cases, or 1 in 2.5, and is the most frequent cause of death, though not, I believe, the most frequent untoward complication of this operation. It might at first be supposed that, in this respect, the operations on the subclavian artery resembled other of the greater operations, after which pneumonia is so common a sequela; but, on closer examination, it will be found that this is not the case. Inflammation, when attack-

ing the thorax or its contents after ligature of this artery for axillary aneurism, is not confined to the lungs, but very commonly affects the pleura and pericardium as well as, or even in preference to, these organs. It would, therefore, appear probable that it arose from causes that are essentially connected with this disease or operation. These are referable to three heads.

1. Inflammation of the deep areolar tissue at the root of the neck may extend to the anterior mediastinum, the pleura, and pericardium. This would appear to have been the cause of death in a patient in whom Key tied the subclavian, and has been especially adverted to by that excellent surgeon in his relation of the case.

2. The sac may, by its pressure inwards, encroach upon and give rise to inflammation of that portion of the pleura that corresponds to its posterior aspect. This occurred in a case in which Mayo, of Winchester, operated, and is more liable to happen if suppuration have taken place in the sac; when this happens, adhesion may take place between it and the pleura, or even the tissue of the adjacent lung; and the contents of the suppurated tumor may be discharged into the pleural cavity or air-tubes, and so coughed up. Of this curious mode of termination there are at least two cases on record; one by Bullen, in which the patient recovered; the other by Gross, in which the patient died from the escape of the contents of the sac into the cavity of the pleura.

3. Division of the phrenic nerve would necessarily, by interfering with the respiratory movements, induce a tendency to congestion and inflammation of the tissue of the lungs; and, although such an accident must be a very rare one in cases of ligature of the subclavian for axillary aneurism, yet it undoubtedly has occurred, as I have myself witnessed in one case.

Suppuration of the sac is the most common, though not the most fatal, accident after ligature of the subclavian for spontaneous axillary aneurism. It was the immediate cause of death in six cases, and occurred in two of the patients that died of inflammation of the chest; it also took place in six cases that recovered: in all, fourteen cases out of forty-five, or nearly one in three—a much higher proportion than is generally observed in cases of ligature for aneurism.

What occasions this greater frequency of suppuration of the sac in axillary aneurisms than in those in other situations? The only cause to which it appears to be attributable is the great laxity of the areolar membrane in the axilla, which allows the tumor to increase so rapidly in size as to excite inflammatory action in the surrounding tissues, which may speedily run into suppuration. So long as the contents of the tumor continue fluid, they will necessarily excite less irritation on surrounding structures; but when once they have become solidified, whether by the gradual deposition of laminated fibrine, during the progress of the disease, or more suddenly, in consequence of those changes that take place in the contents of an aneurismal sac after the ligature of the artery leading to it, the indurated mass, acting like any other foreign body, sets up inflammation in the areolar tissue that is in immediate contact with it, and thus disposes it to run into suppuration. The more speedily the solidification takes place, the more disposition will there be to the occurrence of this accident; the neighboring parts being unable to accommodate themselves to the sudden extension and compression they are compelled to undergo.

The period at which suppuration of the sac may be expected to occur in cases of axillary aneurism, after the ligature of the subclavian, must necessarily in a great measure be dependent on the state of the sac at the time of the operation. If inflammatory action have been already set up around it, it may happen in a few days after the artery has been tied. But if this morbid action have not already commenced, the period at which suppuration may most probably be expected is between the first and second month. The period at which suppuration and rupture of the sac take place does not influence the probable termination of the case to any material extent; as, in the cases that proved fatal, death occurred at various periods between the seventh day and the second month; in Aston Key's case, on the ninth day; in Mayo's on the twelfth; in Belardini's and Gräfe's, at the end of the first month; in Rigaud's at the sixth week; in B. Cooper's, in the second month. The recoveries, likewise, took place at all periods after the ligature of the vessel, between a few days, as in Porter's, and six weeks, as in Halton's case.

An axillary aneurism that has suppurated may burst either externally, or into the lungs or pleura, or both. It is most usual for it to burst externally; the tumor enlarges, with much pain and tension; a part of the skin covering it becomes in-

give way, discharging most usually a quantity of dark-colored pus, mixed up with more or less broken-down and disintegrated coagulum and fibrinous deposit, and perhaps sooner or later followed by a stream of arterial blood.

Occasionally, but more rarely, the sac extending backwards becomes adherent to the pleura, and may give way into that cavity; or, by pressing upon, may become incorporated with the lungs. Of this remarkable termination two instances are recorded, in one of which recovery took place.

The first case of the kind, is one in which Bullen ligatured the subclavian artery for axillary aneurism. Eighteen days after the operation the tumor began to increase, and to take on the symptoms that are indicative of suppuration. On the twenty-sixth day six or eight ounces of bloody pus were expectorated during a paroxysm of coughing, and the tumor suddenly diminished to one-half its size; it was now punctured, and five ounces of the same kind of matter let out with great relief. When the patient coughed, air passed into and distended the sac through an aperture between the first and second ribs, near their sternal extremities, through which the contents of the tumor had escaped into the lung. The discharge from the external aperture greatly decreased; the cough lessened; and finally, three months after the operation, the patient was quite well.

Gross tied the subclavian artery for axillary aneurism on the 18th of February. After the performance of the operation the contents of the tumor solidified, and its volume progressively diminished. On the 15th of March, the patient suffered from fever, and slight tenderness on the apex of the tumor was perceptible. On the 16th he was suddenly seized with intense pain in the chest, which was particularly severe at the base of the right lung, and extended up towards the axilla. The respiration throughout the right lung was bronchial, and there was dulness on percussion over the lower ribs; the aneurismal tumor had suddenly disappeared at the time of the attack. On the 18th, the patient experienced a sensation as if a fluid were passing from the pleuritic cavity into that of the aneurismal tumor; and, upon auscultating, a plashing sound was heard at every inspiration, the noise resembling that produced by shaking water in a closed vessel. On the 20th, he died. Upon dissection, the aneurism was found to communicate by an aperture, one inch and three-quarters in length and an inch and a half in width, with the pleural cavity; this opening was situated between the first and second ribs, and was obviously the result of ulceration and absorption, caused by the pressure of the tumor. Both ribs were denuded of their periosteum. The right side of the chest contained nearly three quarts of bloody serum, intermixed with laminated clots and flakes of lymph; the former of which had evidently been lodged originally in the aneurismal sac (Norris, in *American Journal*, 1845, p. 19).

Besides these cases, a somewhat similar one has been recorded by Neret, of Nancy. A patient was admitted into the hospital, laboring under hæmoptysis, and on examination was found to have an aneurism of the left subclavian artery as large as a chestnut. He died shortly after admission; and, on examination, the aneurism was found to communicate with a large cavity in the upper part of the lung.

The cause of death in Gross's case was probably the fact of the sac opening and discharging its contents into the pleural cavity. This does not appear to have occurred in Bullen's, in which a communication was established directly with the lung, the contents of the abscess finding exit through the air-tubes. The process here was analogous to what occasionally occurs in hepatic abscess, when this opens through the lungs, adhesion having previously taken place between the opposed surfaces of the pleura.

In Furner's case of axillary aneurism, both arteries became affected by the disease, and both subclavians were tied in the third part of their course at an interval of about fifteen months. In this most remarkable and interesting case, the result of which reflects much credit on the skill and decision of the operator, the patient, a stone-mason by trade, made an excellent recovery from the first operation. After the second operation he progressed most favorably for twelve weeks, by which time the tumor had diminished so much as to be not more than a third of its original size. Without obvious reason febrile disturbance set in, the tumor enlarged again and showed signs of suppurating. Furner now made a free incision into it through

the pectoral muscle, and let out 18 or 20 ounces of very offensive pus and broken-down coagulum. The patient speedily recovered, the tumor disappearing entirely.

The principal danger, and the most frequent cause of death after the suppuration of the sac, is the supervention of profuse arterial hemorrhage. This may either occur from the distal extremity of the artery opening into the sac, or from one of the large branches which serve to support the collateral circulation round the shoulder, such as the subscapular or posterior circumflex, coming off either immediately above or below the sac, or from the sac itself. When hemorrhage does not take place after the suppuration of the sac, it must be from the fortunate circumstance of the occlusion of the main trunk, where it opens into the tumor. It can scarcely be from the occlusion of the principal collateral branches; as there would, in this event, be a difficulty in the preservation of the vitality of the limb. It is easy to understand that, if the sac sprang from the axillary, at a little distance above the orifices of the subscapular and circumflex arteries, all that portion of the main trunk which intervenes between the tumor and these vessels might be occluded, and thus hemorrhage be prevented on suppuration taking place; whilst the collateral circulation would take place uninterruptedly through these vessels. If this portion of the artery have not been occluded by inflammatory action, the safety of the patient must depend upon the accident of a coagulum or piece of laminated fibre being fixed or entangled in the mouth of the sac. This may prevent for a time the escape of arterial blood, which, on such a plug being loosened, may break forth with impetuosity, and either at once, or by its recurrence at intervals, carry off the patient.

Another danger may be superadded in these cases on the suppuration of the sac and the supervention of hemorrhage—namely, the occurrence of inflammation of the pleura, lung, and pericardium, from the extension inwards of the morbid action going on in the sac.

Secondary hemorrhage does not frequently occur in cases of ligature of the subclavian artery in the third part of its course, except as a consequence of suppuration of the sac. I am acquainted with two cases only in which death occurred from the hemorrhage taking place from this artery at the part ligatured. One of these happened to Liston, and the preparation is preserved in the Museum of the College of Surgeons (No. 1695). In this case, it may be seen that the artery was diseased at the point ligatured, and that the bleeding occurred, as usual, from the distal side of the ligature.

Gangrene of the hand and arm is but seldom met with as a sequela of the operation we are considering. This is doubtless owing to the freedom of the anastomosing circulation between the branches of the transversales colli and humeri, and those of the subscapular, circumflex, and thoracic acromial arteries; as well as between the superior thoracic and the branches of the first and second intercostals and internal mammary, by which the vitality of the limb is readily maintained. The principal risk from gangrene would doubtless arise from the subscapular artery being in any way occluded or implicated in the disease, as it is on the anastomoses of this vessel that the limb is mainly dependent for its supply of blood. But, at all events, this danger is small, the only case in which it appears to have given rise to a fatal termination being one in which Collis tied the artery; gangrene of the limb came on after much constitutional disturbance of a low type, with rapid, weak pulse, thirst, sweats, restlessness, and delirium. In Blizard's case, there was sloughing of the sac, and pericarditis, the gangrene being confined to two fingers: and in Brodie's case, it occurred in both the lower as well as in the upper extremities, and must, therefore, have proceeded from some constitutional cause altogether independent of the mere arrest of circulation through the subclavian.

Treatment of Inflamed Axillary Aneurism threatening Suppuration.—The case of an axillary aneurism becoming inflamed, and threatening to run into suppuration before the surgeon has had an opportunity of ligaturing the subclavian artery, is one that is full of important practical considerations, and that admits of little delay; for if the sac rupture, or be opened, fatal hemorrhage is the necessary and inevitable result. It would obviously be impossible, in a case of spontaneous aneurism, with any fair chance of success to lay open the tumor, turn out the coagula, and ligature the vessel above and below the mouth of the sac; the coats of the artery, being not only diseased, but still further softened by inflammation and supervening suppuration, would not be in a condition to hold a ligature. There are two other

in the selection of one or other of these, the surgeon must be guided by the progress the disease has made, the condition of the limb as to circulation and temperature, and the solidity or fluidity of the contents of the tumor.

If the tumor be of moderate size and circumscribed, and the arm of a good temperature and not very œdematous, *ligature of the artery* may hold out a reasonable chance of success. It is true that this is but a chance; for the blood will, immediately after the noose is tied, be carried by the supra-scapular and posterior scapular arteries into the subscapular and circumflex, and by them into the axillary at no great distance from the mouth of the sac; or it may enter directly into the mouth of the latter if the profunda or circumflex should chance to take their origin from the dilated portion of the vessel. Hence, the only safeguard against the supervention of hemorrhage as soon as the sac has burst or been opened, or has discharged its contents, will be the occlusion by inflammatory action of that portion of the artery which intervenes between these two collateral branches and its mouth, or the accidental entanglement in the latter of a mass of laminated fibrine. Yet, in the circumstances as to the condition of tumor and limb that have just been mentioned, it would be but right for the surgeon to give the patient a chance of preserving his limb.

Should, however, hemorrhage occur on or after the discharge of the contents of the sac, the subclavian having previously been ligatured, what should be done? If the bleeding be moderate, an attempt should be made to arrest it by plugging the wound, and by the application of a compress and bandage. If it recur, or be so profuse as to threaten the life of the patient, what course should the surgeon then pursue? Two lines of procedure are open to him: either to cut through the pectoral muscles so as to lay the sac open fully, and attempt to include the bleeding orifice between two ligatures; or to amputate at the shoulder-joint.

If a surgeon were to undertake the first of these alternatives in a case of spontaneous aneurism, of which alone we are now speaking, he would, in all probability, find the part in such a condition as would prevent the possibility of his completing the operation he had commenced. After laying open a large sloughing cavity, extending under the pectoral muscles perhaps as high as the clavicle, and clearing out the broken-down coagula and grumous blood it contains, in what state would he find the artery? Certainly, the probability would be strongly against its being in such a condition as to bear a ligature, even if it could be included in one. Its coats, in the immediate vicinity of the sac, could not, in accordance with what we know to be almost universally the case in spontaneous aneurisms of large size or old standing, be expected to be in anything like a sound, firm state, and would almost certainly give way under the pressure of the noose; or the vessel might have undergone fusiform dilatation, as is very common in this situation, before giving rise to the circumscribed false aneurism, in which case it would be impossible to surround it by a ligature; or, again, the subscapular or circumflex arteries might arise directly from, and pour their recurrent blood into, the sac or the dilated artery, and, as they would lie in the midst of inflamed and sloughing tissues, no attempt at including them in a ligature could be successfully made. In such circumstances as these, the danger of the patient would be considerably increased by the irritation and inflammation that would be occasioned by laying open and searching for the bleeding vessel in the sac of an inflamed, suppurating, and sloughing aneurism, and much valuable time would be lost in what must be a fruitless operation; at the close of which it would, in all probability, become necessary to have recourse to disarticulation at the shoulder-joint, and thus remove the whole disease at once. I should, therefore, be disposed to have recourse to *disarticulation at the shoulder-joint* at once, in all cases of profuse recurrent hemorrhage, following sloughing of the sac of an axillary aneurism, which could not be arrested by direct pressure on the bleeding orifice, after the subclavian has been tied.

There is another form of axillary aneurism that requires immediate amputation at the shoulder-joint, whether the subclavian artery have previously been ligatured or not; it is the case of diffuse aneurism of the armpit, with threatened or actual gangrene of the limb.

Ligature of the Axillary Artery.—Should ligature of the axillary artery at any time be required, the vessel may be secured in two ways, in the space that intervenes between the lower margin of the clavicle and the fold of the axilla.

The first way is by an incision, either straight or somewhat semilunar, parallel to and immediately below the inferior border of the clavicle; this must be carried through the pectoral muscle, and, when this is divided, some loose areolar tissue, in which the upper thoracic artery ramifies, is exposed. This must be scratched through cautiously, until the fascia covering the vessels is reached. On opening this, which must be done in the most careful manner by making a small aperture in it, and then passing a grooved director under it, the vein first comes into view. This must be drawn downwards, when the artery will be found immediately above and behind it in the deep hollow formed by the clavicle above, and the edge of the lesser pectoral below. This operation is an exceedingly difficult one, on account of the depth and narrowness of the wound and the muscular character of its walls, as well as from the embarrassment occasioned by the numerous venous and arterial branches which ramify across the space in which the artery lies. After the vessels have been exposed, the passage of the ligature round them will be greatly facilitated by bringing the arm to the side of the body, so as to take off all tension from the wound.

The safer and simpler operation consists in making an incision from the centre of the clavicle directly downwards, in the course of the vessels, to the middle of the anterior fold of the axilla. In this way the skin, superficial fascia, and greater pectoral muscle, must be successively divided. The lesser pectoral will then be exposed; and the artery may either be ligatured below this, without further division of muscular substance, or if it be thought desirable to deligate it under this, the muscle must be cautiously cut through. When this is done, a very distinct and firm fascia will come into view; this being pushed up, must be carefully opened, when the artery and vein will be seen lying parallel to one another, the artery not being overlapped by the vein, as it is higher up. The vein having been drawn inwards, the aneurism-needle must be carried from above downwards between it and the artery. The great advantage of this operation is, that the wound is open and free, and that, consequently, the artery can be more readily reached in any part of its course. The disadvantage is the great division of muscular substance that it entails. This, however, need not leave any permanent weakness of the limb, as by proper position ready and direct union may be effected between the parts.

ANEURISM OF THE ARM, FOREARM, AND HAND.

Spontaneous aneurism rarely occurs below the axilla, yet it may occasionally be met with at any part of the upper extremity. Thus Palletta, Flajani, Pelletan, and others, relate cases of spontaneous aneurism at the bend of the arm; and Liston states that he once tied the brachial artery in an old ship-carpenter, who, whilst at work, felt as if something had snapt in his arm. Pilcher has recorded a case of aneurism under the ball of the right thumb, which was produced by repeated though slight blows with the handle of a hammer used by the patient (a working goldsmith) in his trade; the radial and ulnar arteries were tied immediately above the wrist, and the disease was thus cured. Aneurism has also been met with in this situation after attempted reduction of the thumb. In the Museum of the College of surgeons there is a preparation of a radial artery with a small aneurism, about the third of an inch in diameter, formed by the dilatation of all the coats of a narrow portion of one-half the circumference of the vessel, a little above the origin of the superficialis volæ. Spontaneous aneurism in the forearm is of extremely rare occurrence. A case has been recorded by Todd as occurring in a woman twenty-eight years of age, where a spontaneous aneurism in the forearm had existed for several years before the brachial was ligatured, when pulsation in the tumor ceased, though it continued solid and hard for some months after the operation. De Morgan has recorded a case of spontaneous aneurism of the ulnar, and Spanton one of the radial artery. In neither case was any operation performed. In 1849, a man was admitted into University College Hospital, for a tumor that presented all the characters of aneurism, situated in the upper third of the ulnar artery of the right forearm. The brachial was ligatured by Arnott, when pulsation and bruit ceased in the tumor, though slight enlargement of the arm continued for some time afterwards. In most of the cases in which the brachial artery and its primary branches have been the seat of spontaneous aneurism, disease of the heart and of the arterial system in other parts has coexisted.

the disease are, as has been stated (p. 207), of more frequent occurrence, and may require the ligature of the brachial, or of either of the arteries of the forearm.

Treatment.—In cases of aneurism below the axilla, direct pressure might be tried with advantage, provided the tumor be of small size and unattended by inflammation of the superjacent integuments. Compression of the trunk of the artery above the tumor is rarely applicable, on account of the pain that is induced by the pressure upon the neighboring nerves which cannot be isolated from the artery. Besides this, the brachial artery is so mobile, and the humerus so small and round a bone, that the vessel cannot be steadily compressed against it for any length of time; it will roll away from under the pressure, even if the patient could bear the pain of it.

Ligature of the Brachial Artery.—The brachial artery may be ligatured in the *middle of the arm*, which is considered the seat of election of this operation, by making an incision, about three inches long, parallel to and upon the inner edge of the biceps, which is the "directing line;" the fascia, which is exposed, must be opened carefully to a corresponding extent, when the median nerve will commonly be seen crossing the wound; this must be drawn downwards with a blunt hook, when the artery, accompanied by its two veins, will be exposed; these vessels must then be separated from one another, and the ligature passed and tied in the usual way. In performing this operation, the principal point to attend to is to cut down upon the inner edge of the biceps, which will be the sure guide to the artery. If the surgeon keep too low, he may fall upon the ulnar nerve and the inferior profunda artery, which might possibly be mistaken for the brachial; but, by taking care to expose the lower fibres of the biceps in his early incision, he will avoid this error.

In the *upper part of the arm*, the brachial artery, where the axillary terminates in it, will be found lying immediately behind and covered by its vein. On drawing this to the inner side, the artery will be seen, the plexus of nerves being somewhat above and behind it. In ligaturing the artery in this situation, care must be taken to divide the integuments, which are extremely thin, with great caution; by rotating the arm outwards and bending the elbow, the artery will be thrown forward and rendered less tense, so that a ligature can easily be passed round it.

At the *bend of the arm*, the brachial artery may be reached by making an incision, about two inches in length, in a direction downwards and inwards, about half an inch internal to the edge of the tendon of the biceps. After carrying it through the skin and fascia, the vessel will be found accompanied by its veins, in the triangular space bounded externally by the biceps tendon, and internally by the pronator teres. In performing this operation the veins at the bend of the arm, with the filaments of the internal cutaneous nerve, must be divided to some extent, though they should be spared as much as possible. The artery will be found, about half an inch to the inner side of the tendon, accompanied by the median nerve, which is to its ulnar side.

Ligature of the Radial and Ulnar Arteries.—These arteries should never, I think, be ligatured *above the middle third of the arm* except in cases of direct wound. Any attempt at tying them in the upper part of the forearm will not only be attended with great difficulty, but with the danger of crippling the muscles in this situation, and thus impairing the after-movements of the arm. Ligature of the brachial artery may always be substituted advantageously.

The *radial artery* may be ligatured near the wrist, by making an incision, about two inches in length, half an inch to the outside of the tendon of the flexor carpi radialis—the "directing line;" when, after the division of the superficial and deep fasciæ, the artery, accompanied by its two veins, will be exposed, and may be tied in the usual way.

The *ulnar artery* above the wrist may be readily ligatured by making an incision about two inches in length, a little above and one-third of an inch to the radial side of the pisiform bone, parallel to the tendon of the flexor carpi ulnaris, which is the "directing line" to the vessel. After the fascia covering it has been divided, the artery, with its two accompanying veins, will be found to the radial side of the ulnar nerve.

CHAPTER XLV.

ANEURISMS OF THE LOWER EXTREMITY.

INGUINAL ANEURISM.

An *iliac* or *inguinal aneurism* may arise from the external iliac, or from the common femoral artery; most frequently it springs from the latter, and, taking a direction upwards, pushes the peritoneum before it, and thus encroaches somewhat upon the cavity of the abdomen. The aneurism is commonly of the circumscribed false variety, though sometimes tubular. It never becomes diffused, for the reason long ago pointed out by Scarpa, that the femoral artery, above the edge of the sartorius muscle, is invested by so dense a sheath, and is so closely bound down to the neighboring fascia, that, when dilated into an aneurism, it does not readily give way.

Symptoms.—When first noticed, the aneurism is a small, soft, compressible tumor, with pulsation and bruit, and is generally attended by little pain or uneasiness. It rapidly enlarges, however, and may attain a considerable magnitude; being often somewhat lobulated upon the surface, owing to the unequal constriction exercised on it by the fasciæ under which it lies. At the same time, it usually becomes more solid; and the pulsation in it diminishes considerably, or even ceases entirely. As it increases in size, it compresses the saphena and femoral veins, thus giving rise to œdema of the limb; and, by stretching the genito-crural and some of the branches of the anterior crural nerves, it occasions considerable pain in the thigh and leg.

Diagnosis.—The diagnosis of inguinal aneurism is not always so easy as might at first appear. It has most frequently been confounded with abscess in the groin, with carcinomatous tumors in this situation, and with osteo-aneurism. The diagnosis from *abscess* must be made on general principles; but in some instances it appears to be replete with difficulty, as there are not a few cases recorded in which aneurisms in this situation have been mistaken and punctured for abscess, an error that has in every instance proved fatal. The diagnosis of an inguinal aneurism, solidified by the deposition of laminated fibrine, and pulsating but indistinctly, from a *pulsating encephaloid* or *osseous tumor* in the groin, is surrounded by the greatest difficulty, and cannot, I believe, with the means we at present possess, be accomplished with absolute certainty. Thé fact of the two diseases having in two instances been confounded during the last few years, by two of the most distinguished surgeons of the day, Stanley and Syme, is sufficient evidence of the difficulty attending their diagnosis.

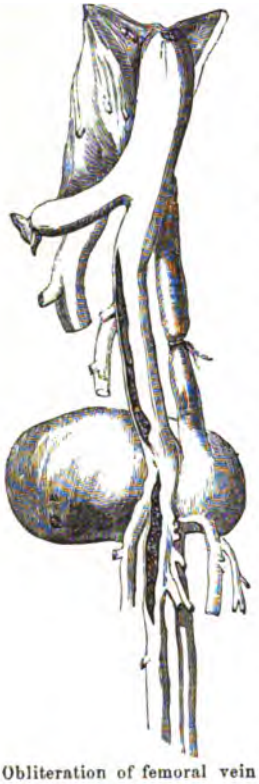
Treatment.—It occasionally happens that inguinal aneurisms, even of a very large size, undergo spontaneous cure, or become consolidated by direct pressure conjoined with constitutional treatment; but these instances are of such rare occurrence, that such a result cannot be relied on in any one case. In the majority of instances the tumor, though it may have encroached on the abdomen, will not have reached too high for the external iliac to be ligatured; should it have done so, however, the surgeon may have to tie the common iliac artery; but in some instances even this may not be practicable, and his choice must lie between the slender chance offered by constitutional treatment and pressure, and the fearful alternative of ligaturing the aorta.

Ligature of the External Iliac Artery was first practised by Abernethy, in 1796. Since that period it has been had recourse to in at least 100 instances for inguinal aneurism (Norris); of these seventy-three were cured, and twenty-seven died. In one remarkable case, both external iliacs were ligatured successfully at an interval of eleven months, by Tait. In some few cases, also, there was the complication of an aneurism in the ham with that in the groin. Of the ninety-two cases in which the aneurism was solely seated in the groin, seventy were cured and twenty-two died. Death resulted from gangrene of the limb in eight, from second-

and from causes of a more general character in four cases.

Pulsation returned in the sac in six cases; in some not until several weeks had elapsed after the operation; and in one instance only was this phenomenon followed by death. *Suppuration of the sac* was of frequent occurrence, happening in thirteen instances, doubtless owing to the large size that these tumors are often allowed to attain before being subjected to surgical interference. It is remarkable, however, that in three cases only was this accident fatal; and in two of these three instances the sac had been opened before the operation, on the supposition of its being an abscess. *Secondary hemorrhage* occurred but in six cases, four of which proved fatal; a very small proportion when compared with what happens in other situations. This must doubtless be attributed in a great measure to the absence of any collateral branches springing from the trunk of the external iliac; the distance between the point ligatured and the epigastric and circumflex ilii arteries affording abundant space for the safe obliteration of the vessel. In one of the fatal cases, pulsation had previously returned in the sac; in the other three the patients died on the seventeenth, the twenty-seventh, and the forty-third days respectively.

Fig. 269.



Obliteration of femoral vein by inguinal aneurism.

Gangrene of the limb is the most common cause of death after deligation of this vessel. It occurred in nine instances, of which eight proved fatal; one being cured by amputation. The period at which the mortification supervened varied from the third to the fourth week. The principal cause of this gangrene is narrowing or obliteration of the neighboring venous trunk, by pressure of the tumor. In the accompanying woodcut (Fig. 269) this is well illustrated; the vein opposite the aneurism being completely closed.

It is a very remarkable circumstance in the history of this operation that four deaths have resulted from *tetanus*. This sequence of this particular operation it is difficult to account for, as it is a most unusual occurrence after the ligature of arteries, and is equally rare after wounds of the abdominal wall in other operations, as for hernia.

The ligature of the external iliac for *aneurismal varix in the groin* affords a striking contrast with that for spontaneous aneurism; the four cases recorded all proving fatal, two dying of gangrene, and two of hemorrhage. In these cases Guthrie has recommended that the tumor should be laid open, and the artery ligatured above and below the aperture in it. But, with whatever rapidity and dexterity such a proceeding may be accomplished in the groin, there will be great risk of such a loss of blood ensuing as to endanger the patient's life, there being great difficulty in commanding the artery above the seat of disease.

[Should it be thought proper to have recourse to this operation, the circulation in the aorta should be controlled by the use of Lister's compressor or the abdominal tourniquet.—A.]

Aneurism occasionally takes place *in the groin and ham of the same side;* here the ligature of the external iliac will cure both diseases. Of four cases in which this complication occurred, the operation was successful in three; one patient dying of gangrene, and in him the popliteal aneurism was on the point of bursting at the time of the operation. In two of the three cases that recovered, pulsation returned in the inguinal aneurism, but disappeared after a time.

Operation.—There are two modes of tying the external iliac artery—the one originally practised by Abernethy, somewhat modified by Liston; and the other introduced by Sir A. Cooper.

Abernethy's method modified consists in commencing an incision two finger-breadths above, and somewhat to the inner side of, the middle of Poupart's ligament, and carrying it upwards and outwards to the extent of about four inches, so that it terminates at about three finger-breadths to the inner side of the anterior superior spine of the ilium. After dividing the skin and superficial fascia, the fibres

of the external oblique tendon are carefully cut through. The internal oblique and the transversalis muscles are then cut through with great caution, when the transversalis fascia is reached, which is recognized by its dull white appearance. A small portion of this membrane, at the lower angle of the wound, where it is thinned and expanded for the passage of the cord, is now carefully raised with the forceps and scratched through with the point of the scalpel. A director is then introduced, and passed underneath it, when it should be laid open upwards and outwards to the full extent of the wound; the whole of the inner side of the wound is next drawn towards the mesial line, the peritoneum being separated from its loose areolar connections in the iliac fossa by the surgeon's fingers; it must be kept out of the way by an assistant, who holds it up with a broad bent copper spatula. The artery may now be felt pulsating at the bottom of the wound, covered by a dense fascia and having the vein lying to its inner side, and somewhat behind it. The investing sheath must be scratched through in two situations, and the needle passed from the inner side between the vessels, the ligature being then tied in the usual way.

In *Sir A. Cooper's operation*, an incision about three inches in length is made a little above and nearly parallel to Poupart's ligament, beginning above the inner margin of the abdominal ring, and ending near the anterior superior spine of the ilium. By this incision the tendon of the external oblique is exposed, and must be divided to the full extent of the external wound, when the spermatic cord will be seen passing under the lower edge of the internal oblique and transversalis muscles. Some loose areolar tissue and fascia has now to be scratched through; and the finger, being passed under the cord, will come into contact with the external iliac artery, close to the spot where the epigastric is given off from it; the upper side of the incision must now be well raised by a copper spatula, when the vessel will be exposed, covered by an areolar sheath, and having the vein to its inner side; the sheath must be cautiously opened, and the ligature passed in either direction.

On comparing the two operations, it would appear that the principal disadvantage of Abernethy's is, that it is apt to leave a tendency to hernial protrusion, in consequence of the abdominal wall being much weakened by the free incisions through the muscular planes that are necessary; the great advantage attending it is, that the external iliac may be ligatured at any part of its course, and that, if requisite, the incision may be even extended upwards, and the common trunk secured. In Sir A. Cooper's operation, the line of incision lies directly across the course of the epigastric artery, which, as well as the circumflex ilii, if it arise high, and the circumflex vein, which crosses the iliac artery at this point, and is often somewhat funnel-shaped, may be in danger of being wounded. The spermatic cord is likewise somewhat in the way in this operation. Dupuytren actually wounded the epigastric artery in one case; and Houston had much difficulty from the circumflex vein in another instance. This operation has also the disadvantage, that by it it is impossible to prolong the incision upwards so as to deligate any portion of the vessel except that which lies immediately above the crural arch; but the peritoneum is less disturbed than in the other case, and there is less tendency to hernial protrusion afterwards. As a general rule, I think we may conclude that in cases of spontaneous aneurism, in which it might, from the size of the tumor or the diseased state of the vessels, be found necessary to apply the ligature to a higher point than was intended before the operation commenced, it will be safer to have recourse to Abernethy's plan, modified as above described, as in this way we shall be able to ligature the vessel at any part of its course; whilst in cases of hemorrhage after amputation, or of traumatic femoral aneurism, in which the artery is not likely to be diseased, recourse should be had to Cooper's operation, more particularly if the patient be thin, and the abdomen flat.

In connection with the ligature of the external iliac artery, there are some practical points that deserve mention. Before the operation the colon should be emptied by means of an enema, and the pubes shaved. The incision in the abdominal wall must be sufficiently extensive, but should never be allowed to implicate the external ring, lest it give rise to a tendency to hernial protrusion. Care should be taken not to wound the peritoneum; for, although two patients in whom this was done by Post and Tait both recovered, yet it is of course a dangerous accident, and should if possible be avoided. The peritoneum must not be torn up more than is absolutely necessary, lest hemorrhage or subsequent peritonitis occur; and especially care must be taken that the fascia transversalis be properly divided, otherwise the iliac

inner side of, and perhaps slightly overlapped by this, is the sheath of the vessel s
this must now be cautiously opened, the long saphenous nerve being respected, an
the aneurism-needle unarmed passed between the artery and vein, from within o
wards, about four inches below Poupart's ligament; it should then be threaded
withdrawn, and the ligature tied. The edges of the wound must now be br
into contact by a couple of stitches and two strips of plaster; the limb being
flexed, somewhat raised, laid on its outer side, and wrapped in soft flannel o
wadding. The severe pain which is usually complained of about the knee
tightening of the ligature may best be relieved by a full dose of opium.

In this operation there are several points of considerable importance
special attention. The ligature should always be applied about four
Poupart's ligament, so that sufficient space may intervene between th
deep femoral, which is usually from one to two inches below the cro
has, indeed, happened that the ligature has been placed within th
point deligated, to admit of the formation of a proper coagulum
inch of the origin of the deep femoral, without any injurious con
The proper point, however, for the deligation of the artery is
is usually the very spot at which the sartorius crosses it; the
very broad, it may be necessary to draw it to the outer side.
it. In cutting down upon the artery, the saphenous vein
should if possible be avoided. After the sheath has been
be found that a rather large muscular branch is given o
the part where it was intended to ligature it; if so, thi
as well as any small veins that cross the main trunk i

The femoral vein, which lies behind and somewhat
is best avoided by passing the needle from within o
the inner side of the sheath being at the same tim
upon it with a pair of forceps. After the needle
side of the artery, a small portion of the she
pushed up by it; this must be divided by bein
the scalpel, when the needle may be carried r

Results.—Ligature of the femoral artery
that has been so frequently performed, th
cases of this description, unless they pres
interest or severity; hence but little imp
deductions from reported cases as to
may serve as a rough estimate of the
accidents, such as hemorrhage, gang
the femoral artery is attended with
trunks, can admit of no doubt. T
experience of surgeons, but is co
without making allowance for th
cessful having been recorded.
the femoral artery had been li
to have died; amongst these
by gangrene, and the other
of mortality are, however
one in four die after th
operated on in London

Accidents.—Wou
dent that can happen
and is one of which
aneurism; as in th
vessels often bec
action having e
best avoided b
unarmed, and
fatal, there
it; death u
The true
who sho
fixed a

neither of these conditions be found, the surgeon must not be disappointed, but pierce the neighboring osseous tissue in different directions by means of a perforator, when perhaps the abscess will be opened; should it not be so, the patient will still in all probability be materially benefited by the removal of the circle of bone and the consequent relief to the compression of the osseous tissue. After the operation, the cavity left must be dressed from the bottom with wet lint, and a poultice afterwards applied; it will gradually fill up with fibrous tissue, leaving the unimpaired in utility and strength.

In very chronic cases of circumscribed abscess of bone, chronic oste considerable portion or the whole of the shaft may slowly take place becoming greatly enlarged, thickened, and generally diseased from end to 274 is a representation of a section of the tibia in such a state of com ration and inflammatory hypertrophy; removed by amputation from had suffered for 23 years from the disease. In such cases, amputa is the sole means of relief.

CARIES.

By caries some surgeons mean a kind of ulceration of bon disintegration of the osseous tissue; and Stanley includ various changes consequent on chronic suppuration of But caries, I think, properly means a disease of the bone, vascularity, softening, and ultimate disintegration of the to consist in a breaking down of the organized portion of which the earthy matters become eliminated in a g diffluent form in the pus formed by the inflamma healthy structures.

Structure.—On examining a portion of cari porous and fragile, of a gray, brown, or black softened masses, and partly hollowed out into and oily fluid. The process of wasting whic partly the result of ulceration, and partly of cases, small masses of dead bone lie loos Around this carious portion, the bone, membranes, are usually extremely vascul masses of osseous tissue will be found forming its exterior wall. These char cellous structure, but the compact t quently occurs in the cancellated t bones; and here the disease is ex destroy the contiguous articular caries of the articular ends of and is a very frequent cause destruction of cartilage, follo be affected by caries, but it cancellous bones.

Causes.—Caries usuall struma or syphilis, often strumous constitutions, cancellated heads of th in the centre of the b many cases without of vitality in those osteum, and which of blood from an of the soft investi are consecutive to

In *syphilitic cons* grating and eroding by Stanley as true *ul* analogous to ulcers of but leaves the surface

Marshall's osteotrite.

bone, and thus removing the whole of the diseased structures. In some cases Marshall's *osteotrite* (Fig. 275) will be found a very serviceable instrument, clearing away the softened carious bone without risk to the surrounding healthy structures.

In removing the carious bone with these instruments, the surgeon may be sometimes at a loss to know when he has cut away enough. In this he may generally be guided by the difference of texture between the diseased and healthy bone; the former cutting soft and gritty, readily yielding before the instrument, whilst the latter is hard and resistant; so that, when all the disease is removed, the walls of the cavity left will be felt to be compact and smooth. In some cases, the healthy bone may have been softened by inflammation; should there be any doubt as to the condition of what has been gouged out, it may be solved by putting the *detritus* into water, when if carious, it will either wash white or black; whereas, if healthy, but inflamed, it will preserve its red tint. In operating on young children especially, it is well not to have the gouge too sharp, lest the inflamed, but otherwise healthy though somewhat softened bone, be cut away together with the disintegrated caries. The cavity that is left should be lightly dressed from the bottom, and allowed to heal by granulation, when it will gradually fill up by the deposition of fibrous material in it.

When caries affects the articular ends of the bones, as those that enter into the formation of the elbow or shoulder-joints, it may be so situated as not to admit of removal in the way just indicated, but to require *excision* of the diseased articulation: this operation we shall consider in a subsequent chapter. When caries involves a bone so extensively that neither of the preceding plans can successfully be put into operation, it becomes necessary to perform either the *resection* of the whole of the bone, if it be of small size, or *amputation* of the limb, if of greater magnitude, or if the neighboring joints be extensively affected. Thus, for instance, resection of the os calcis may be required for caries of that bone; while, if the whole of the tarsus be affected, amputation is the only resource.

[A preparation has been introduced by M. Notta, as a local application to carious bone, under the name of "Liqueur de Villate." It may be made according to the following formula: ℞. Zinci sulphatis, cupri sulphatis, āā gr. xv; liq. plumbi subacetatis, f℥ss; acid. acet. dilut., vel aceti alb., f℥iijss.—M. I have seen this used at the Pennsylvania Hospital by Dr. Hewson, with apparently good results, and have occasionally employed it myself at the Episcopal Hospital, but I must confess without any marked benefit.—A.]

NECROSIS.

The transition from caries to *necrosis* is easy. Caries may be regarded as the granular disintegration or molecular death of the osseous tissue, conjoined with suppuration of the surrounding healthy parts; whilst necrosis must be looked upon as the death of the osseous tissue as a whole—a condition, indeed, closely resembling that of gangrene of the soft parts. Whilst caries, however, chiefly affects the cancellous structure, necrosis is met with in the compact tissue of bone, and far more frequently occurs in the shafts than in the articular ends of the long bones. It is, however, an error to suppose that the cancellous structure is exempt from necrosis; thus, in the head of the tibia, or in the os calcis, small masses of necrosed bone are not unfrequently found lying in the midst of carious or suppurating cavities. Different bones are affected by necrosis with varying degrees of frequency. The tibia at its anterior part is most frequently diseased; the femur in its lower third is also very commonly affected. The lower end of the humerus is not so often necrosed; but not uncommonly the phalanges of the fingers from whitlow, the skull from syphilis, the lower jaw from the emanations evolved in the manufacture of phosphorus matches, and the clavicle and ulna from injury or constitutional causes, are found affected by necrosis.

Causes.—The causes of necrosis are of very various character. We have just

seen that it is *predisposed* to by the structure of particular parts of bone, and is more frequent in some bones than in others. Among the more constitutional causes, we may rank in the first line those cachectic conditions of the system that result from scrofula and syphilis, and those debilitated states of constitution that so frequently follow upon scarlet or typhoid fever. In these various states, the bone may suddenly lose its vitality, more especially if the limb be subjected to slight accident, as concussion, or to exposure to some degree of cold. Sometimes the disease results from the vitality of the bone being destroyed by the extension of inflammation to it from the neighboring tissues, as in some cases of whitlow, or by the bone becoming exposed by a neighboring abscess.

Age exercises a predisposing influence on necrosis. It is not very common in young children, except as associated with caries of the bones of the hands and feet. When it does occur in the long bones in early life, it is usually very acute. In early adult age it is common in the long bones, more particularly the femur and the humerus, and then is usually the direct consequence of injury or of syphilis.

In other cases, simply as the result of old age, a bone or a portion of a bone dies suddenly, apparently by simple extinction of vitality, without any injury or other evident exciting cause. This I have seen occur in the lower ends of the humerus and of the tibia, giving rise to rapid and usually to fatal disorganization of the neighboring joints. This *senile necrosis* may be looked upon as the counterpart in the bone of senile sloughing or gangrene in the soft parts.

Acute febrile disturbance, more particularly scarlet and typhoid fevers, are not unfrequent exciting causes of necrosis in the young. Scarlet fever especially is apt to be followed by pains in the leg and about the knee, which at first appear to be of a rheumatic character, but which speedily run into abscess and are attended by all the symptoms of the most acute form of necrosis.

Traumatic causes frequently give rise to necrosis. Thus the denudation of a bone by its periosteum being stripped off, may lead to its death; but, though the bone thus injured often loses its vitality, yet, if the membrane be replaced, its life may be preserved; even when it is exposed, adhesions may take place between it and the neighboring soft parts, or granulations may be thrown out by its surface, which eventually form another periosteum. Necrosis frequently occurs as the result of the detachment and denudation of a portion of bone in cases of bad compound fracture; so also the application of certain irritants, as the fumes of phosphorus, may occasion this disease, and hence it has been found that, in lucifer-match manufactories, necrosis of the lower jaw is a frequent consequence of the acrid fumes that are eliminated gaining access to the bone through carious teeth, or being applied to the exposed alveoli.

Characters.—In whatever way it originates, necrosis may affect the outer laminæ only of the bone, when it may be called *peripheral;* or the innermost layers that surround the medullary canal may perish, and then it may be termed *central;* or the whole thickness of a shaft, or of the substance of a short bone, may lose its vitality. The necrosed portion of bone, called the *sequestrum*, presents peculiar characters, by which its nature may at once be recognized. It is of a dirty yellowish-white color, and has a dull opaque look, and, after exposure to the air, it gradually becomes of a deep brown or black tint; the margins are ragged, and more or less spiculated, and the free surface is tolerably smooth, but its attached surface is very irregular, rough, and uneven, presenting an eroded or worm-eaten appearance. This eroded appearance is well marked in sequestra that form in the interior of the terminal end of the femur in a thigh-stump after amputation, and is well illustrated by Fig. 8, where the lower smooth part is composed of the whole thickness of the bone, the upper rough and spiculated portions of the central portion of bone being separated from the outer layer, and hence being apparently eroded on their exterior. When the sequestrum forms in the cancellous structure, it is usually of a blackish-gray color, irregular but somewhat ovoid in shape, as if the bony matter had been partially dissolved away; and here it is frequently conjoined with caries of the surrounding bone.

Symptoms.—The symptoms of necrosis are divisible into two distinct periods. In the first, the bone dies and undergoes separation, and an attempt is made by nature at the expulsion of that portion of it which has lost its vitality. In the second period, the reparative processes for the restoration of the proper length and shape of the shaft are carried on. The particular character of the symptoms depends,

of the necrosis. In all cases it is ushered in by symptoms of local inflammation of a more or less intense and painful character; the skin becomes glazed, œdematous, and of a purplish-red tint; abscess, often of large size, and discharging great quantities of fetid or bloody pus, forms in the limb, and burrows widely, in proportion to the extent of the necrosis, amongst its areolar planes. If the suppuration be not so extensive as to jeopardize life, as occasionally happens when the thigh is the seat of the disease, the patient sinking into rapid hectic, the suppurating cavity will gradually contract, leaving fistulous and sinuous tracts, often of great length and extent, leading to rough and bare bone, discharging a fetid and ichorous pus, and having their orifices surrounded by protuberant and glazed granulations. All these symptoms of inflammation, abscess, and widely spread suppuration, have for their ultimate objects the separation and elimination of the dead bone, and the proper formation of new bone as a substitute for that which has died. They are in the first instance occasioned by, and are not the cause of, the death of the bone. When a bone or a portion of a bone necroses, it becomes to all intents a foreign body. The soft tissues around resent its presence, and endeavor to throw it off by an inflamtory action, just as they would act if any extraneous substance, as a piece of wood, were thrust in amongst them. But the ultimate result of the action thus set up is not limited to the separation of the dead bone, but extends to the formation of material destined to repair the loss of substance occasioned by the separation and extrusion of the dead bone.

In *pheripheral necrosis* of the shafts of the long bones, as of the femur or tibia, the inflammatory symptoms just indicated are well marked, and the disease usually runs a rapid course up to the period of the formation and discharge of the abscess. In the case of *central necrosis*, the pain is usually more severe than in the former case, and is peculiarly deep-seated and throbbing, being especially intense at night. The limb becomes very œdematous, red, and glazed; the bone enlarges greatly, and abscess at last forms, which spreads widely in the planes of areolar tissue, undermining the muscles, and producing general destruction of the limb, the tissues of which become rigid and condensed, having sinuses leading down through them. On introducing a probe into these channels, the instrument passes through apertures into the bony case, termed *cloacæ* (Fig. 276), at the bottom of which the dead bone will be felt rough and bare. Though this is the general condition that occurs in central necrosis, it occasionally but rarely happens that a small portion of some of the internal lamellæ of the bone dies, and, being included in a greatly thickened case of new bone, gives rise to symptoms of osteitis, or closely resembling those of circumscribed abscess of bone, but not to those characterizing necrosis.

When the *whole thickness of a shaft* dies, the symptoms are always of a very acute kind, the extent and gravity of the inflammatory and suppurative condition being proportioned to that of the amount of bone that loses its vitality. It is a remarkable fact, however, that the articular ends usually escape, though even these sometimes become affected, and the joints involved. When the *short cancellated bones* or the *articular ends of long bones* become the seat of necrosis, it commonly happens that the disease is far more chronic than in the other cases; abscess forms, which at first may not reveal its true nature, or, being preceded by continual pain, may be looked upon as a disease of rheumatic character. Suppuration at last occurs, sometimes rapidly opening into the neighboring joint, and disorganizing it with extreme constitutional disturbance; but more commonly it runs a very chronic course. On passing the probe down the fistulous openings that lead through the indurated and thickened soft parts, an aperture may usually be felt in the bone, at the bottom of which lies a necrosed mass not larger than a hazel-nut, surrounded by carious bone.

Acute necrosis especially attacks the shafts of the tibia and femur. In these cases violent and deeply-seated pain occurs in the limb, which becomes generally inflamed, with much redness and great swelling. Abscess soon forms along the whole line of bone between it and the periosteum; and great constitutional disturbance ensues, which may lead to removal of limb as the only means of saving life. This form of necrosis chiefly occurs in young and cachectic subjects, usually as a sequel of a febrile attack, such as scarlatina or typhoid fever, or from exposure to severe cold. I have also seen it occur as a senile disease in the tibia, the humerus, and in the fibula of persons of an advanced age, from sixty-five to seventy-five years.

eventually regain its normal size and shape.

Amputation.—If the necrosed bone be so situated that it cannot be removed, occupying too great an extent and continuing to be firmly fixed; and if, at the same time the patient's health have been worn down by constant discharge, and symptoms of hectic come on; or if the limb have generally been greatly disorganized by the morbid processes going on in it, recourse must be had to amputation as a last resource. It is especially in the lower third of the thigh-bone that these severe forms of necrosis occur, necessitating amputation of the limb. When necrosis affects the flat posterior surface of this bone above the condyles, a special source of danger occurs in the possibility of the sequestrum causing ulceration or wound of the popliteal artery. In cases of this kind suddenly fatal hemorrhage might occur. Should the hemorrhage, though abundant, not be fatal, what course should the surgeon adopt in such cases? Should he attempt to ligature the vessel, or should he amputate the limb? The line of practice must, I think, be determined by the condition of the limb itself and by the state of the patient's health. If these be both tolerably good, the limb not too much disorganized, and the powers of the system not too much reduced by hectic, an attempt might be made, by slitting up the sinuses, to expose and secure the popliteal artery at the seat of injury in it, and, by ligaturing it, to save life and limb. But should this attempt fail, as I have known happen, or should it not be thought prudent to make it, owing to the low state of the patient's strength or the disorganized condition of the limb, amputation must be done without delay. As an idiopathic disease, necrosis of the tibia requiring amputation is rarely met with; but when it is the result of bad compound fractures, or of other serious injuries, removal of the limb may become imperative. In acute necrosis of the lower end of the thigh, or of the shaft of the tibia involving the contiguous joints, and attended by deep and extensive abscess of the limb, amputation is imperative.

Resection of the whole of the necrosed bone may be advantageously performed in those cases in which, as in the cases of the metacarpal and metatarsal bones, or in those of the forearm or leg, sufficient stability of limb is secured by the remaining bone or bones to leave a useful member. The diseased bone may be thus removed in the case of necrosis of the ungual phalanx occurring from whitlow, where, by the excision of the dead bone, the end of the finger may be preserved; also in necrosis of some of the metatarsal and tarsal bones, or those of the forearm, the inferior maxilla, and the fibula.

The remarks that I have hitherto made apply chiefly to necrosis of the long bones of the extremities. As there are a few special considerations connected with necrosis of the flat bones, we will now consider these briefly.

Necrosis of the Sternum, Scapula, or Bones of the Pelvis, is an excessively tedious process, there being but very little tendency to the formation of the line of separation and the detachment of the sequestrum, which will continue bare, rough, and adherent for many years. Should it be so situated that it can be removed, it must be excised, even though not detached. When the ilium and pelvic bones are affected independently of the hip-joint, it is seldom that any operative measure can be employed with advantage; here we must leave the patient to the chance of the bone being at length so loosened as to admit of extraction. In some cases, however, if the disease be limited to a portion of the crest of the ilium, or to the tuber ischii, the dead bone may be removed; although in these instances it not uncommonly happens that disease of a similar kind exists elsewhere, about the sacrum or spine, that will eventually destroy the patient. In a case in which I removed a portion of the crista ilii for necrosis that was apparently confined to that bone, it was found, on the patient dying some weeks afterwards of erysipelas, that the lumbar vertebræ were also diseased. Of late years, considerable portions of the pelvis have been successfully excised for necrosis, as will be more fully mentioned when I come to speak of excision of the hip-joint. The tuber ischii, when affected, may readily be extirpated.

Necrosis of the Cranial Bones is of frequent occurrence as the result of struma or syphilis, or the two conditions conjoined. When met with in children, it is usually strumous, often occurring after measles or scarlet fever; in adults it is usually syphilitic, though by no means invariably so, being sometimes the result of blows in people of otherwise healthy constitutions. There are four situations in

which necrosis of the cranial bones may occur, viz., in the vault of the skull, the frontal bone, the temporal bone, or in the sphenoid and ethmoid bones. When idiopathic necrosis affects the vault, it is usually syphilitic; when it occurs in the other situations, especially in the temporal bone, it is commonly strumous.

Three forms of necrosis affect the cranial bones. In one case, the outer table is alone affected; this perishes, separates, and exfoliates: granulations then spring up from the outer surface of the inner table, and a process of repair is thus established. In the second form of the disease, the whole thickness of the skull necroses, separates from the dura mater and surrounding healthy bone in the usual way, and may be detached in large irregularly shaped pieces, sometimes of large size, occupying several square inches. In the third form, the necrosis is hard, dry, rough, and pitted or worm-eaten, penetrating through the diploë to the inner table, separating very slowly, and lasting an indefinite period.

Results.—In necrosis of the cranial bones, there is always the special danger of extension of morbid action to the membranes of the brain, and the consequent occurrence of inflammatory effusion within the skull, leading to convulsions, coma, and death. This danger is greatest when the petrous portion of the temporal bone is affected, as the structure of this bone is homogeneous, and the dura mater is continuous with the lining of the cavities by which it is perforated. Cerebral complication is less likely to occur when the frontal bone is the seat of disease, more particularly the lower part of this bone, where, by the intervention of the frontal sinuses, the anterior wall is altogether carried away from the inner table, and from all dangerous proximity to the membranes of the brain.

The *signs* of necrosis of the cranial bones are very obvious. When the vault or forehead is affected, there is tenderness, with some puffiness, and gradual elevation of the scalp into an abscess. When this is opened, the necrosed bone may be felt or seen lying, dry and dark, at the bottom of a sinus or unhealed ulcer. When the petrous portion of the temporal bone is the seat of disease, there will have been ear-ache, followed by profuse fetid discharge from the ear, with perforation of the tympanum, escape of the ossicula auditûs, and deafness. When the sphenoid or the ethmoid is affected, deep pains in the head, persistent œdema of the eyelids, and fetid discharge from the nose, will reveal the nature and seat of the mischief.

The *treatment* of necrosis of the cranial bones will vary according to the nature and the seat of the disease. In the dry pitted variety, exposing and scraping the diseased osseous surface will often bring about a healthy action, provided the disease have not penetrated too deeply. Should there be reason to think that the inner table has been perforated, it will probably be safer to leave the case to the reparative processes of nature than to trephine. If, however, the anterior wall of the frontal sinus be the seat of the disease, or if the supra-orbital ridge be affected, the dry and rough bone may be safely removed, as I have on more than one occasion had to do, by the application of the trephine in the first instance, and of the gouge in the other case. When exfoliating necrosis of the outer table, or of the whole thickness of the bone, affects the vault of the skull, the loosened plate may readily be lifted off its granulating bed by means of the elevator or forceps, after it has been fairly exposed.

Necrosis of the petrous portion of the temporal bone may be looked upon as an incurable disease, which is usually fatal from encephalitis. When the sphenoid or ethmoid are the seat of necrosis, little can usually be done by operative interference; though in the latter case portions of sequestrum may sometimes be extracted through the nostrils.

The **Patella** is rarely necrosed. I have, however, met with two instances of primary necrosis of this bone. One case occurred in an elderly woman. The disease came on without any evident external cause, commencing in the anterior part of the patella and gradually implicating the bone, until it became perforated, when rapid suppurative disorganization of the knee-joint ensued, necessitating amputation. The other case occurred after simple fracture of the patella, in a man, and is described at page 282.

Ribs.—When the ribs are necrosed, abscesses and sinuses will often form to a considerable extent on the side of the chest. These must be laid open, and the diseased portion of bone scraped away by the gouge. In doing this, care must of course be taken that the adjacent intercostal space be not punctured by an unfortunate slip of the instrument—an accident that is best avoided by protecting the gouge well with the finger.

CHAPTER XLVII.

STRUCTURAL CHANGES IN BONE.

THE bones are liable to various structural changes, by which their size, shape, and consistence are modified, or in consequence of which they become the seat of tumors of various kinds.

Hypertrophy of bone usually results from inflammation of the osseous tissue, but in some cases it may occur apparently without having been preceded by any signs indicative of this condition; it then resembles in character some of the forms of exostosis that will presently be mentioned.

Atrophy of bone occurs, as a natural result, in old age. In other cases it happens as a consequence of fracture; the nutritious artery of the bone having been torn across, and one of the fragments consequently receiving insufficient vascular supply. Atrophy of bone also commonly occurs from disuse, as is the case in old dislocations. In cases of hypertrophy, the bone is not only enlarged in circumference, and also perhaps in length, but is indurated, becoming specifically heavier. In atrophy, on the other hand, it is thinner, lighter, and more porous than usual, the compact structure disappearing, and the cancellous being expanded.

RICKETS, MOLLITIES OSSIUM, AND SCROFULOUS OSTEITIS.

Rickets is a disease of early life, usually being met with in scrofulous children, and never occurring after the age of puberty. In it the structure of the bones is changed, the earthy matter being deficient, and the organic material in excess; so that the bone continues to be soft, flexible, and cartilaginous in structure, at an age when its tissue ought to have undergone proper consolidation. It appears to be atrophied, and the cancellous structure to be expanded into cavities of varying magnitude, which contain a brownish-red serous fluid. In consequence of the change of structure and the loss of firmness in the bones in this disease, considerable distortion of the body takes place. The *head* early appears large and expanded; indeed, Kilian states that rickets always first appears in the head, the forehead being especially protuberant; according to Stanley, this arises not from enlargement of the cranial bones, but in consequence of the want of development of those of the face; the head thus appearing large from its disproportion to the small face. The shape of the *limbs* is much changed and distorted, in consequence of their yielding to the pressure of the superincumbent weight; the pelvis becoming contracted, and the thighs and legs bent either forwards or outwards. The *joints* are usually swollen, the articular ends of the bones appearing enlarged. In early life the *chest* will be observed to be deformed in a peculiar manner, being narrowed above, where the upper ribs are contracted and pressed in, but expanded below, apparently from the weight of the abdominal viscera, which are often tumefied, and in these cases drag on the lower ribs. As puberty advances, lateral curvature of the *spine* commonly takes place. In rickety children there is a general delicacy of appearance, and often a strumous habit of body, though, according to Rokitansky, they are not usually tuberculous; if they live, however, past the age of puberty, they may eventually become sufficiently powerful in frame.

The *treatment* of rickets must be conducted on the same general principles that guide us in cases of scrofula; pure air, good food, and plenty of it, regular exercise, and the administration of tonics, especially the preparations of iron with scrupulous attention to the general habits of life of the child, will generally improve his condition to the utmost limits compatible with the powers of his constitution, and will, by improving the nutrition of the system, tend to the more healthy deposition of osseous matter. In some cases, the administration of lime-water with milk seems to be of service in supplying those elements that are required by the system. It is of much importance in preventing deformity in these cases not to allow the child to

walk or stand much, but to let it take exercise in donkey-panniers or hand-chairs, and to support those limbs that have a special tendency to become excurvated, with properly constructed steel supports, which will be found of much use, provided they are not too heavy, or interfere with the action of the muscles. Methodical friction should also be employed, so as to stimulate the muscles; as these become more vigorous, their osseous attachments have a tendency to become stronger.

[Dr. Gee, who has seen an immense number of cases of rickets at the Hospital for Sick Children, recommends most highly the administration of cod-liver oil, which he regards as almost a specific. (*St. Bartholomew's Hosp. Reports*, vol. iv. p. 79.)—A.]

Mollities and Fragilitas Ossium—Osteomalacia.—A very rare but most destructive and dangerous disease of the bones, characterized by softening and fragility of the osseous structure, is occasionally met with. This affection has of late years been studied with much attention by Curling, Solly, Stanley, MacIntyre, and Litzmann; and it is principally from their labors that we are acquainted with the principal facts relating to it.

In this disease the bones are bent, their epiphyses swollen, and their shafts broken in various parts of the body. Occasionally, though very rarely, only one is fractured; but in other cases, as in Tyrrell's, there may be as many as twenty-two fractures, or, as in Arnott's, thirty-one. These fractures are unattended by any attempt at the formation of callus. The body becomes singularly and distressingly distorted. On examining the bones after death they will be found to be light, soft, and somewhat gritty—bending, and at the same time readily snapping across; occasionally they are expanded and thickened. This happens especially with the skull, which becomes often considerably increased in substance. On cutting the bones, which are soft and yield something like cartilage, the knife usually encounters a kind of gritty sensation. On making a section of the bones they appear of a deep reddish-brown or maroon color, and will be seen to contain cavities of various sizes, small or large, but always of a circular or oval shape, and generally filled with an oily, red, and grumous fluid, though sometimes they contain clear serum. On examining this red grumous matter under the microscope it shows a cell-development; hence Solly remarks that it is probably an adventitious morbid product, and not simply fatty matter altered by the effusion of blood into it. Dalrymple has shown that this material is composed of granular matter, nucleated cells, and a few caudate corpuscles; he therefore believes it to be a disease essentially malignant in its nature, but differing from other malignant affections; for, "instead of progressively reproducing and developing themselves without limitation, the new and morbid formations which replace the original and sound structure seem to have been at an early stage of their existence removed by absorption and carried out of the system" (MacIntyre). It is, however, more reasonable to consider with Virchow that this condition merely represents a retrograde conversion of osseous substance into medullary tissue, which under certain circumstances appears as an extraordinarily soft and very vascular structure, rich in cells; or as a gelatinous and semi-fluid substance. An excessive production of medullary spaces takes place by absorption of the laminated structure, whilst the osseous corpuscles either become converted into the new cells, or disappear.

In chemical composition, the diseased bone has been found by Leeson to be composed of 18.75 animal matter, 29.17 phosphate and carbonate of lime, and 52.08 of water in every hundred parts.

Cause.—The cause of the complaint is obscure. It would appear that it is frequently connected with a rheumatic tendency; as, in every case recorded, the affection has been preceded or accompanied by severe pains, or distinct rheumatic attacks. In some instances the patients have been affected with syphilis. In a majority of the cases it appears to have a connection with the childbearing state. It most commonly, though not invariably, occurs in females, as pointed out by Kilian. Among 131 patients whose histories have been collected by Litzmann, of Kiel, there were 85 females, in whom the disease either appeared during pregnancy and labor, or was modified in its course by these conditions. Of the remaining 46 patients 35 were females and 11 males. It most generally attacks adults, having been observed in few cases under the age of 20: and it may occur even at a very advanced age.

The *seat of the disease*, according to Litzmann, varies according as it occurs within the childbearing period, or independently of this. In 85 childbearing women,

in 2; while in 46 other cases, all parts of the skeleton were diseased in 21, and all the bones except those of the head in 6. The percentage of the occurrence of the disease in various parts is shown in the following table:—

	85 childbearing women.		46 other cases.
Pelvis	96	—	87
Spinal column	54	—	87
Chest	31	—	80
Lower limb	17	—	78
Upper limb	12	—	62
Head	8	—	52

In childbearing women the disease appears to have a remarkable predilection for the pelvis; it is probable, however, that a careful examination of all the bones has not been made in all cases.

State of the Urine.—In all cases that have been recorded, the urine has been seen to contain large quantities of earthy matter. Solly pointed out that this is phosphate of lime, which has been absorbed from the bone, and thrown out by the kidneys in the urine; and sometimes the elimination of this matter is so abundant that it forms, as in one of the cases which he relates, a solid calculus, clogging up the interior of the kidney. In MacIntyre's case, the earthy matters of the bone appear to have been, in the first instance, absorbed, and carried off from the kidneys by the urine; but afterwards an animal matter, of a peculiar and apparently previously undescribed character, was discharged in abundance.

Symptoms.—These are in the early stages, extremely obscure and insidious. The patient complains, in the first instance, of wandering pains about the limbs and trunk; these assume usually a rheumatic character, though they have been observed to be of a much more severe, persistent, and intractable nature than in any form of rheumatism. The patient becomes debilitated, unfitted for exertion, and emaciated. Spontaneous fracture now occurs in some bones under the influence of the most trivial causes; others become bent, and the body consequently greatly misshapen and distorted. The urine presents some of the abnormal characters above described, and death eventually results from general exhaustion.

Diagnosis.—The diagnosis of this affection has to be made in the early stages from *rheumatism*. This is not always easy, and, indeed, is at first impossible; but after a time, when the peculiar phosphatic condition of the urine and the fragility or distortions of the osseous system manifest themselves, the true nature of the affection becomes apparent. From *rickets* the diagnosis may usually be readily made, by observing that, whilst rickets is a disease of children, osteomalacia is peculiar to adult or advanced life. The severe pains and the great distortion, with the tendency to spontaneous fracture which is observed in this disease, are never noticed in rickety children.

Treatment.—With regard to treatment, but little can be done; the administration of tonics, and a general supporting plan of treatment, may arrest for a time the progress of this terrible affection; but when once it is declared, it usually progresses from bad to worse, and at last destroys the patient. Opiates may be employed to allay the pain, and in MacIntyre's case some temporary advantage appeared to result from the administration of alum; but no remedy has appeared to exercise any continuous advantage in this complaint, which, there is reason to believe with Solly, is truly malignant.

Scrofulous Osteitis.—The scrofulous affections of bone constitute an important section of the diseases of this tissue in children and young people, who are the subjects of this diathesis. They have been for the most part described as the results of the deposit of tubercle in this tissue, but are almost always connected with chronic inflammatory processes of a low type, whilst the true gray granulations are but rarely found. The characteristic feature of this disease is the production of chronic osteitis and periosteitis, circumscribed abscess, caries, and necrosis. These changes most commonly take place in the cancellous tissue, and consequently affect the epiphyses of the long bones more than the shafts, and frequently lead to implication and destruction of the contiguous joints. In the short bones, as those of the tarsus, they commonly lead to caries and necrosis; and affecting, as they often do, the bodies of the vertebræ, very frequently giving rise to some of the most

destructive diseases of the spine, attended by the formation of large lumbar and iliac abscesses. Under the influence of this diathesis, a low form of inflammation is readily established in the osseous tissue, as the result of any slight exposure to external violence or change of temperature; and this rapidly leads to caries, with the formation of curdy pus in which masses of softened tissue may be seen. If this destructive action take place with great rapidity, portions of the bone will be found to necrose in small masses, which lie at the bottom of these carious cavities, as may commonly be observed in some forms of strumous caries of the os calcis and head of the tibia. These scrofulous vomicæ undermine the overlying articular cartilage, and thus opening up the interior, give rise to the most destructive suppurative disorganization in it. Fig. 285 is a representation of one of these vomicæ in the head of the tibia, their most common seat. When the inflammation has been of a more acute character, it may cause disintegration of the whole of the articular end of a long bone, with separation of the epiphysis. These destructive changes may take place with great rapidity; I have seen them happen in a lad, whose thigh I amputated for acute strumous infiltration of the lower end of the thigh-bone, in less than a month from the first occurrence of the complaint; the patient, at the time of the operation, being nearly exhausted by hectic, induced by the abundant discharge from the diseased bone, and from immense abscesses in his thigh.

Fig. 285.

Scrofulous vomica in head of tibia.

When, on the contrary, the changes are limited to a very small area in an otherwise healthy bone, the diseased portion may, as it undergoes softening, dispose to the occurrence of circumscribed abscess, at the same time that chronic thickening and condensation of the surrounding bone take place. It is in consequence of this condensation of the peripheral portion of the bone by the deposit of fresh layers of osseous tissue under and by the inflamed periosteum, and the difficulty that the contents of the abscess necessarily experience in traversing the hypertrophied osseous structure, that the diseased product is so apt, when deposited in the vicinity of a joint, to work its way through the cartilages into the cavity of the articulation; as on this surface no fresh deposit nor condensation of osseous tissue can take place, and consequently no additional obstacle is offered to the outward progress of the inflammatory products, or rather of the curdy pus into which they have become transformed.

The existence of these changes in the osseous tissue thus not only gives rise to destruction of the bone and adjacent articulations, &c., but will occasion inflammation and extensive suppuration in the neighboring soft parts; indeed, some of the largest chronic abscesses that form in the body, those connected with diseased dorsal or lumbar vertebræ, owe their origin in the majority of cases to the deposition and disintegration of these lowly organized products in the bones. When once caries has been established in a bone and the osseous boundaries containing the *débris* have become perforated with the accompanying plastic infiltration and abscess and sinuses of the soft parts, &c., these conditions will continue in a permanent manner; the fistulous tracks leading down to the bone, and the cavities in it, remaining open so long as any unsound matter is left at the bottom of them; and in this way the patient may eventually be exhausted by the copious and continuous discharge from the osseous vomicæ. In some favorable cases as the result of natural processes, and in others by those operations that the surgeon practises for caries, the whole of these products may be disintegrated, and thus eventually eliminated, a true vomica being left in the bone, or scooped out by the gouge; and then the fistulous track, whether in the soft parts or in bone, having no longer this kind of foreign body lying on its bottom, will gradually close—not by the contraction of its osseous walls, which is of course impossible, but by the deposition of a fibrous tissue by which the cavity is occluded.

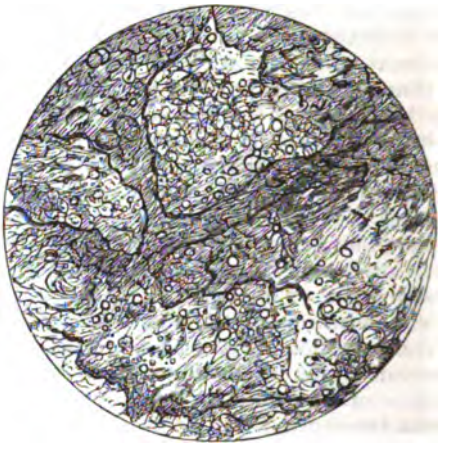
Pathology.—Nélaton has devoted special attention to the pathology of these affections, to which he applies the term tubercular, and with which he classes the only variety to which the name properly belongs, viz., that derived from the deposit of gray granulations in the osseous tissue. He describes two forms of tubercle in this situation; the first is the *encysted* variety, which occurs in the form of small

vascular and spongy, apparently of a cellular structure. This variety is stated by Nélaton to be the most common. I have certainly not found it so, but have most frequently met with the infiltrated opaque tubercle. The other form in which tubercle occurs, according to Nélaton, is an *infiltration* into the cancellous structure of bones. This may be in the form of semi-transparent granulations of a grayish or rosy tint, opalescent and slightly transparent; occasionally these granulations are firm, so as almost to resemble cartilaginous deposits in the interior of the bone. The osseous structure, in the midst of which this kind of tuberculous matter is deposited, does not appear at first to undergo any material alteration. Tubercle may also be infiltrated as opaque puriform, matter of a pale yellow color, soft, and without vascularity (Figs. 286, 287). The osseous tissue, under the influence of

Fig. 286.

Scrofulous osteitis of tibia.

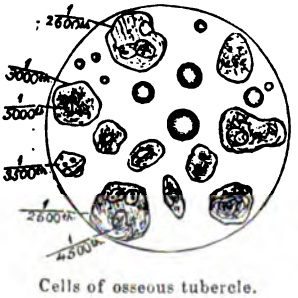
Fig. 287.



Scrofulous osteitis; magnified 250 diameters.

this disease, often becomes, as Nélaton observes, more condensed than natural, the cells being obliterated so as to resemble the compact substance of bone. In some cases it may continue thus chronically thickened and indurated; but in other instances the tuberculous inflammation will give rise to rapid and destructive inflammation of the surrounding osseous tissue, which becomes excessively vascular, and crumbles down into a carious state, with some necrosed masses intermixed. In other instances, as is not unfrequently observed in some of the forms of caries of the spine, or of white swelling, slow suppuration takes place in the interior of the bone; and on the sides or in the centre of the abscesses thus formed, hardened and white ivory-looking masses and knobs of osseous tissue may be seen to be deposited; these apparently consisting of tuberculous bone that has undergone some special modification of structure. All these changes, with the exception of that described as the gray infiltration, appear to be due rather to chronic inflammatory changes, accompanied by an impaired nutrition and imperfect attempts at repair, than to the development of a distinct new formation derived from the pre-existing tissue by cell proliferation. Virchow proposes the name of scrofulous osteomyelitis, as more truly expressing the conditions present in these cases than that of tubercle, which he would limit to the following variety.

Fig. 288.



Cells of osseous tubercle.

Tubercle of bone, in the limited sense in which this term is here employed, is undoubtedly a rare affection. True miliary tubercle in the form of gray granulations, which undergo cheesy changes, and lead to softening and necrosis of the parts around, is occasionally found in the cancellous tissue of the epiphyses, or more commonly in the spongy structures of the bones of the

tarsus (Billroth). It is absolutely impossible to form any exact diagnosis of the nature of the changes going on in the bone, which can only be determined by an examination of the conditions of the other organs. There can, however, be no doubt that the bones of young people, the subjects of tuberculous disease in the restricted sense of the term, are very liable to become affected with caries from very slight causes. In fact, in both strums and tubercle nutritive functions are imperfectly performed, and tissues formed under these influences readily suffer when put to any severe trial.

Treatment.—The treatment of tubercle of bone resolves itself into that of its effects. As its existence cannot be recognized except by the changes which it induces in the bone, the treatment must be directed exclusively to these. Thus, if it occasion circumscribed abscess, this must be opened; if caries, the diseased cavity and tissue must be scooped out, or removed in accordance with the principles already laid down; and if disease of the neighboring articulations result, it must be managed in the way that will hereafter be explained.

It is of importance, however, to recognize the dependence of these various affections of the bones on a scrofulous or tuberculous constitutional state, as it is specially necessary in these conditions that suitable measures should be adopted for the removal of the cause. Thus, good food, sea air, the administration of iron, of the iodides, and cod-liver oil, will form most important elements in the treatment; and without these, indeed, it cannot be brought to a successful termination. The progress of these cases is generally excessively tedious. Stanley gives two years as the time required for a strumous bone to recover itself; and in very many instances this period may even be exceeded. In this, as in all other chronic inflammatory affections of the bone, it is of considerable moment to continue the means of cure until the disease is fully recovered from; for relapse will occur with special readiness in the tubercular affections, if the patient be allowed to use the diseased limb or part too soon.

TUMORS OF BONE.

Exostosis.—By exostosis is meant the growth of a bony tumor from some of the osseous structures of the body. The causes that immediately give rise to this disease are usually extremely obscure. There can be no doubt that, in some instances it is predisposed to by syphilis, scrofula, or cancerous affections; and that in other cases, again, it is hereditary; but, in general, it occurs without any distinct or appreciable exciting cause. It chiefly occurs in the young, developing itself about the age of puberty. Exostosis appears to originate in two ways; being either primarily formed and deposited as true bone; or in other cases being the result of the ossification of an enchondroma.

Exostoses are of two kinds—the one hard and compact, the other softer and more spongy. The hard, or *ivory exostosis*, is a structure that differs both in appearance and composition from true bone. It is extremely compact and white, having a granular section closely resembling that of ivory, and presenting somewhat radiating fibres, but possessing a true bony structure, Haversian canal, lacunæ, and lamellæ. In chemical composition, it is found to differ from healthy bone in containing more of the phosphate and less of the carbonate of lime, and also in the proportion of animal matters being smaller. This kind of exostosis principally grows from the flat bones, and, as it is generally of small size, seldom produces much inconvenience, unless it project into and compress inportant parts. Thus, Cloquet relates the case of a tumor of this kind growing from the pubic bone, and perforating the bladder; and it is occasionally found to project into the orbit, or from the inner table of the skull, upon the brain. When exostosis is left to itself, it becomes stationary after a time. In some instances it has been known to necrose, and to slough away, as it were, from the parts in which it has been situated. Of this termination Hilton and Boyer relate instances.

The spongy, cancellous, or *cellular exostoses* grow rapidly, often attain a considerable size, and are very commonly multiple. Exostoses of this form are usually primarily enchondromatous, and are not unfrequently found covered with a thin layer of cartilage, which appears to precede their development. When numerous, they will often be found to be somewhat symmetrical in their arrangement. Not unfrequently they stretch across from one bone to another, bridging over joints, and

at others spinous; in structure and chemical composition they are identical with cancellated bone. Their most common seats are, according to Billroth, the tibia, fibula, and humerus.

The *symptoms* of exostosis are simply those produced by a hard, thick, and slowly growing tumor, connected with a bone and pushing forwards the soft parts covering it. In many cases it produces serious inconvenience by its pressure, either upon neighboring organs or mucous canals; or it may occasion ulceration of the skin lying above it.

Treatment.—If an exostosis be so situated as to occasion inconvenience or deformity, it will be necessary to remove it; and as it is a local disease, there is no fear of its return, provided this be fully done. If, however, the whole of it be not taken away, it may grow again; and Stanley accordingly recommends that if it be so situated, as upon the skull, that its base cannot be extirpated, potassa fusa or nitric acid should be applied to the part that is left, so as to produce exfoliation of it. The removal of these tumors is best effected by a Hey's or chain saw, or cutting pliers. In some situations, as when close upon joints, or springing from the cervical vertebræ, they cannot be interfered with; and in other cases, as occasionally happens in the neighborhood of the orbit, their density and hardness may be such that the saw can scarcely work its way through them. There is one variety of exostosis which deserves special attention. It is that form of the disease which springs from the upper surface of the ungual phalanx of the great toe. It forms a small rounded mass, usually about half as large as a cherry, projecting under or beyond the nail, and giving rise to much pain and inconvenience in walking. Dupuytren, who first described this peculiar variety of the disease, has pointed out the treatment proper for it, which consists in exposing it by a double elliptical incision, and cutting it off with the scalpel, or a small pair of pliers, without amputating the toe.

There is a species of bony growth, called *osteoma*, consisting of an uniform elongated mass of new bone, deposited on some of the osseous surfaces, somewhat resembling a node, and differing from ordinary exostosis in not being pedunculated. This does not admit of removal, and is not amenable to any treatment.

Enchondromatous or Osteo-Cartilaginous Tumors are often met with. These have already been described when speaking of enchondroma and its pathology (p. 484), and need not, consequently, be more than adverted to here. They usually require resection or amputation of the affected bone, according to the attachments and size of the growth; but Stanley states that in some cases, where the cartilaginous tumor of bone is of small size, it may be influenced and eventually dispersed by the local application of iodine and mercury.

Cystic Tumors of bone of various kinds are commonly included under the terms *osteo-sarcoma* and *spina ventosa*. The former term properly belongs to the variety of tumor mentioned under this head in the chapter on tumors (p. 486); but, having also been occasionally applied to various other solid growths, whether of a fatty, fibrous, gelatinous, or cartilaginous character, as well as to various kinds of malignant tumor springing from bones, it has occasioned much confusion in the pathology of these affections.

Structure.—The cystic tumors of bone have been well described by Nélaton. They consist of cysts, having various kinds of fluid and solid contents. The cysts may be unilocular, and these are commonly filled with solid matter; or multilocular, and they then contain fluid. The *solid masses* are usually of a fibro-cellular or fibro-cartilaginous character, filling up completely the cavity in which they are situated, and often attaining a very considerable size. They occur principally about the jaws, and articular ends of long bones, especially the humerus, the femur, and the tibia. The *cysts with fluid or semi-fluid contents* attain a much larger size than the last, being often met with as large as a cocoa-nut or a fœtal head. On a section of them being made, they are found to be composed of multilocular cysts, each cavity having distinct walls, and often communicating with others. The fluid contained within these cysts is of various characters, thin and serous, sero-sanguinolent, viscid, or dark colored, often associated with masses of fibrous tumor, appearing as if it proceeded from the central softening of these large growths. The same situations are affected by the compound as by the single cysts, but they are also met with in the shafts of long bones. From whatever part they proceed, their walls are com-

posed of expanded bone, not uniformly thinned, but thickened and nodulated at various parts, whilst it is perforated at others (Fig. 289).

These cystic tumors principally occur in adults, being rarely met with in children. They constitute smooth, round, or oval growths, increasing slowly, but steadily, with little or no pain; the skin covering them being of the normal color, and the veins usually blue, enlarged, and tortuous. When a certain size has been attained, so that the shell of bone is expanded into a very thin lamella, and before it is perforated, pressure on the tumor occasions a peculiar crackling or rustling noise, like that produced by pressing together a broken egg-shell, or the crackling of tin-foil. Under this, the elasticity or even semi-fluctuation of the tumor may be felt. This fluctuation is particularly marked after a time, when the osseous envelope has become still more expanded, or is partially or wholly absorbed.

Fig. 289.

Cystic tumor of lower end of femur.

Treatment.—When the contents of the tumor are solid, there is usually no means of ridding the patient of it but by the removal of the whole growth; by excision, if it be favorably situated for such procedure, as in the jaws; by amputation, if in the limbs. When the contents of the tumor are fluid or semi-fluid, it must, if large, be treated in the same way as the solid growths are; but if it be small, or if of moderate size, so as not to have materially affected the integrity of the bone, it may suffice to remove one side of the wall of the cyst by the trephine or by excision, and then the cavity may be stuffed with lint, and allowed to granulate, and its walls to contract. This plan has proved especially successful in some of the cystic tumors of the lower jaw; and I have had occasion to practise it with success in a small cyst forming in the outer condyle of the humerus.

Myeloid and Fibro-plastic Tumors are not unfrequently met with at the articular ends of the long bones (Fig. 290). They always develop in the cancellous structure; sometimes spontaneously, at other times as the result of a blow or other injury. Even when involving the shaft of a bone, they commence in the central portion of the osseous tissue, and expand outwards. All the long and many of the flat bones are liable to this form of disease. It is most common, perhaps, at the lower end of the femur, and the head of the tibia; in the head of the humerus, and the lower end of the radius; in fact, in those portions of bone where there is most cancellous structure. In the jaw and the scapula it also occurs; and I have amputated the thigh for this disease in the fibula of a lad.

Fig. 290.

Myeloid tumor of lower end of humerus of two years' growth, following fracture of the condyles.

The disease is local in its development and earlier stages, but has a tendency to recurrence after removal, especially if the whole of the affected bone and infiltrated muscles be not extirpated. Its malignancy is proportionate to the rapidity of its growth; and the more rapid this is, the more it will be found to partake of the encephaloid character. Recurrent myeloid, after imperfect extirpation, is always softer, darker, and more malignant in appearance and in action than the primary deposit.

A myeloid tumor, developing in the articular end of a long bone, may burst into the neighboring joint and fill this up with its softened mass. It does this by pushing before it the incrusting cartilages of the joint. These are not destroyed or invaded by the disease; but, the bone by which they are supported being disintegrated, broken down, and destroyed, they necessarily separate and lie loosened upon the morbid mass.

The only *treatment* that can be adopted in cases of mye-

ease, and thus to prevent as far as possible the liability to recurrence.

Hydatids.—Cavities are occasionally, but very rarely, found in bones, in which large numbers of hydatids are lodged; according to Stanley, both the acephalocyst and the cysticercus cellulosæ have been found in this tissue, but most frequently the first. In these cases a cyst forms in the bone, which becomes thin and expanded, resembling the ordinary fluid cystic tumor, but which, on examination, is found to contain the entozoa. The *treatment*, as Stanley observes, must depend on the situation and extent of the disease; if it be a long bone that is affected, and it be much expanded, recourse must be had to amputation; if it be a flat bone, the cavity must be scooped out, and dressed from the bottom with stimulating applications, so that it may fill with healthy granulations.

Cancer.—*Malignant osteoid*, *osteo-cancer*, or *osteo-cephaloma*, are true malignant tumors of bone, constituting very serious but not very rare forms of cancer. Two distinct forms of cancer of bone are included in this disease. In one form the morbid growth is *central*, springing from the medullary canal; in the other it is *peripheral*, being attached to the compact osseous substance.

In the *central* cancer of bone, the tumor is found to grow in the substance of, or to spring from, the interior of the medullary canal of the bone. It is usually situated at or about the articular ends, expanding the bone, which becomes completely enveloped and incorporated in the structure of the growth, either in the form of osseous rays diverging from the centre of the tumor, or more rarely as a thin shell of bone surrounding the mass, as in the more simple growths springing from this tissue. In either circumstance, it is important to bear in mind, this form of disease is never localized, but always invades the whole of the bone. The freedom of communication between the upper and lower ends of a long bone is so great, that, as has been shown by Richet, water injected at one end exudes in a few seconds at the other; hence the juices of a malignant structure may easily traverse the whole length of the bone, and we accordingly find, on examining the osseous tissue at a distance from the tumor, that there are red patches in it here and there indicative of its infiltration with the morbid structure.

In the *peripheral* form of cancer of bone, which is probably the most common variety, the osseous tissue is not so completely invaded; for, although the disease may be situated upon, or be in intimate contact with, the outer layers of the bone, which are incorporated in it, it does not extend into the cancellous tissue or the medullary canal. The tumor appears to spring from the periosteum; and, after removal and maceration, stalactitic projections and radiating fibres may be traced into it from the outer layers of the bone. In this form of osteo-cancer, the muscles that are attached to the affected portion of bone will often be found to be extensively infiltrated with cancer-cells.

Structure.—These tumors, whether central or peripheral, are chiefly of the encephaloid species of cancer, and are met with in all stages of development and of decay. Encephaloid of bone is harder and more fibrous looking than the same affection elsewhere. The cancer-cell also is not so well marked, and indeed may

Fig. 291.

Longitudinal section of the tumor of the bone made by a Valentine's knife.

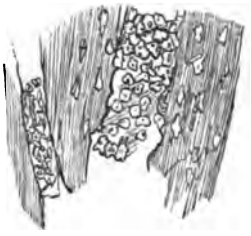
Fig. 292.

Section of infiltrated periosteum.

be absent altogether. Occasionally, some colloid, and more rarely melanotic matter is intermixed; but scirrhus, I believe, is never found in bone.

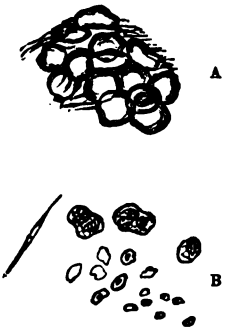
The accompanying cuts (Figs. 291—295) illustrate the microscopical appearances presented by cancer of bone.

Fig. 293.



Section of a Haversian canal, showing the contained cells.

Fig. 294.



(A) Healthy medulla. (B) Morbid medulla.

Fig. 295.

Nucleated cells from the tumor of the bone.

Situation.—Cancer of bone most frequently occurs in the head of the tibia and the lower end of the thigh bone; occasionally in the humerus and in the jaws, more especially about the antrum. It is a remarkable fact, long ago pointed out by Petit, and more recently insisted on by Richet, and which I have often had occasion to verify, that although the epiphysis may have been completely converted into encephaloid matter, the cartilage of incrustation and of the neighboring joint (Fig. 296) never becomes implicated; although the growth may eventually involve and include the whole of the rest of the articulation, by extension to the capsule and its soft parts. When internal organs become secondarily affected in these cases, the deposit will generally be found in the lungs.

Symptoms.—There is usually, with much lancinating pain, a rapidly growing enlargement of the bone, having a globular shape, feeling elastic, and sometimes semi-fluctuating. The skin covering it, at first pale, with numerous reticulated and blue tortuous veins, afterwards becomes discolored, being eventually implicated in the morbid mass. In some cases fracture of the bone takes place at the affected part (Figs. 297, 298, 299); the neighboring tissues are speedily contaminated, the lymphatic

Fig. 296.

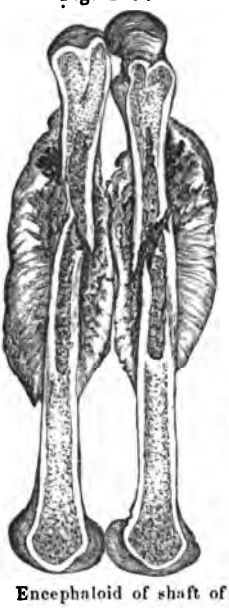
Section of osteo-cephaloma of head of humerus; upper end and head of humerus destroyed, but cartilage of incrustation unaffected. Tumor divided by white vertical lines—the periosteum: inside which only were the osseous spicula found.

Fig. 297.

Osteo-cephaloma of the head of the humerus, with spontaneous fracture of the shaft, in which I amputated successfully at the shoulder-joint.

sinks. In other cases, the disease being central, the progress, especially in the early stages of the disease, is less rapid, though it at last develops itself with fearful violence. So long as the disease is confined within the walls of the bone it develops itself but slowly, and does not show much disposition to affect the constitution. Some years ago I had under my care a man whose thigh I amputated for cancer of the head of the tibia; the disease had existed for four years, encapsuled as it were inside the head of the bone, without contaminating the neighboring parts. The patient's constitution appeared sound, and he made a good recovery. But, when once the soft parts become engaged, the system is speedily contaminated. In some instances pulsation of a thrilling kind, with or without a blowing murmur, is distinctly perceptible, especially in an advanced stage of the affection, when the vascularity of the tumor is greatly increased.

Fig. 298.



Encephaloid of shaft of femur sawn open. Spontaneous fracture.

Fig. 299.

Encephaloid of shaft of femur, successfully amputated at hip-joint.

Diagnosis.—The diagnosis of osteo-cancer has to be made from other tumors of bone, and from aneurism. The malignant growths of bone may readily be confounded with those various forms of *non-malignant disease* that are commonly included under the term *spina ventosa.* In making the diagnosis, we may reasonably come to the conclusion that the growth is cancerous, if it occur in early life before puberty, or between this period and the early adult age; if it increase with great rapidity, and with much pain, especially of a lancinating character; if, to the touch, it present a somewhat diffused pulpiness, with much elasticity, great tension, and, at points, a semi-fluctuating feel; and more especially if the veins be greatly enlarged and tortuous, the neighboring lymphatic glands involved, and if cachexy ultimately set in. These conditions, differing from the slow growth, the more circumscribed character, and more solid feel of the non-malignant tumors, which have no tendency to the implication of neighboring structures, and which occur at later periods of life, usually enable us to make the diagnosis. There is one tumor, however, viz., *enchondroma*, which occasionally, in the rapidity of its growth, closely resembles malignant disease. Here the diagnosis is confessedly extremely difficult; though the more solid character, the less degree of elasticity, and the absence of lymphatic enlargement or implication of contiguous tissues, will often enable us to establish the true nature of a tumor before its removal.

The diagnosis from *aneurism* is necessarily unattended by any difficulty so long as its sac is pervious to fluid blood, and presents the characters that are met with in this condition. But if the sac have become consolidated by the deposit of stratified laminæ, and thus have assumed the characters of a solid tumor, it may readily enough be mistaken for a tumor springing from the osseous structures, and amputation has occasionally been performed on this supposition (as in Fig. 243). Pulsating osteo-cephaloma may be mistaken for simple erectile tumor or for aneurism by anastomosis. In such cases, however, the history of the progress of the disease will do more to elucidate its true nature than anything else, attention being more especially paid to the early symptoms of the tumor, when the aneurism was still filled with blood.

Treatment.—No means are of any avail in cases of osteo-cancer, except the removal of the diseased part by amputation or excision. These operations are, however, not very promising, as there are few forms of cancer in which the disease returns more rapidly in a secondary manner than in that of the bones. The rapidity of recurrence will, however, greatly depend upon the form of the disease, or the time when *amputation* is performed, and on the part where it is practised. Ampu-

tation should always, if possible, be performed in the earliest stage of the disease, before glandular or constitutional infection has set in. If the glands be enlarged, and cachexy have already occurred, little can be expected in the way of ultimate cure; yet I have known cases in which, even in these unfavorable circumstances, the patients have made a good recovery, life having been prolonged for months. I believe that return is much more speedy and certain after amputation in the peripheral than in the central form of osteo-cancer, provided that in the latter the whole of the bone has been removed; this is due to the more extensive contamination of the soft parts in the former than in the latter case.

The selection of the line at which amputation should be performed is of great importance, and the result will materially depend upon the judgment displayed in this. If the limb be removed in the continuity of the diseased bone, there must necessarily be a great probability of a very rapid return of the morbid action in the stump; and this probability amounts to a certainty in those cases in which the disease is central, and in which the whole of the medullary canal and cancellous structure are implicated, and infiltrated with cancer. In cases of peripheral osteo-cancer, this return in the same bone may not take place; indeed, I have seen one case of the kind in which the disease affected the lower end of the tibia, and that bone was amputated in its upper third; in this case, after a lapse of some months, fatal recurrence of the disease took place in the pelvic bones, but not in the stump. As, however, the peripheral is more rare than the central form of the disease, and as there are no means of ascertaining the precise kind before removal, the rule, I think, should be definite to amputate at or above the next joint—at the hip-joint, in cancer of the thigh-bone; in the thigh, for that of the bones of the leg; and at the shoulder, when the upper arm is affected. When the lower part of the thigh-bone, however, is involved, amputation through the trochanters may sometimes be substituted for disarticulation at the hip-joint, the latter operation being so formidable and so fatal that the surgeon may think it advisable not to subject the patient to so serious a risk; or amputation might be performed through the trochanters, and then the head of the bone extirpated from the acetabulum. In this way the severity of the operation and the extent of incised surface would be lessened, whilst the whole of the diseased bone would be removed.

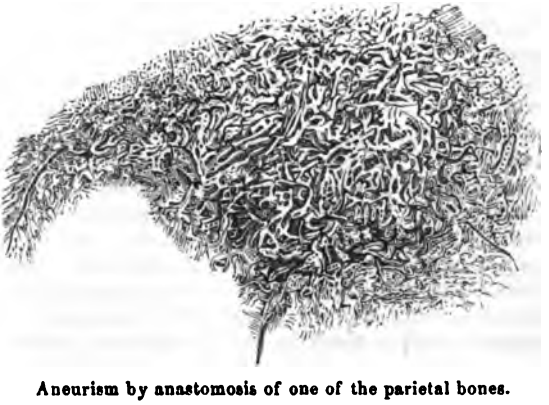
In the peripheral form of osteo-cancer, however, the muscles inserted in the affected bone often become speedily contaminated by the disease, and this contamination may spread widely through the substance of any particular muscle. Hence I think the rule in these cases should be to amputate not only above the diseased bone, but, if practicable, above the origins of the muscles in the neighborhood of the disease; thus, if there be a malignant tumor of the bones of the forearm, amputation should be done not only above the elbow-joint, but above the humeral attachments of the muscles of the forearm.

[It has, I think, been established by the labors of Collis and others, that less sweeping measures will often suffice. Even when the disease begins in the periosteum, if it be early recognized, amputation in the continuity of the bone might offer a reasonable hope of success, and under any circumstances, if the disease were not too far advanced, amputation at the epiphyseal line might be preferable to disarticulation.—A.]

The propriety of *excision* of some bones, as those of the face, in this disease, must depend on whether the morbid deposit is limited to the structures that can be excised. This operation can rarely be advantageously practised in malignant tumors, there being in general too great an implication of the soft structures in the neighborhood to justify it.

Sanguineous Tumors are occasionally met with in bones. Stanley describes them as appearing under two forms: 1. As tumors composed of a vascular substance, having the general

Fig. 300.



Aneurism by anastomosis of one of the parietal bones.

characters of erectile tissue, and bearing on section a close resemblance to certain nævi (Fig. 300); tumors of this kind may be removed without the liability to reproduction: 2. As cysts formed in the cancellous structure of a bone, and containing either fluid or coagulated blood. According to Stanley, these tumors expand the osseous walls, and will gradually cause ulceration of the skin and profuse hemorrhage.

The *treatment* consists in the amputation of the limb, or the excision of the affected bone, as was successfully done by Travers, who removed a clavicle that was the seat of this disease.

Osteo-Aneurism.—Pulsating tumors of bone, or osteo-aneurisms, though of unfrequent occurrence, are of considerable importance to the practical surgeon, on account of the difficulty that often exists in establishing a diagnosis between them and ordinary aneurisms. It is only of late years that this kind of disease has been fully recognized; and it is principally to the labors of Handyside, Nélaton, Stanley, and Roux, that we owe an acquaintance with its characters.

Characters.—Tumors springing from bone, whether of a cartilaginous, fibrous, or cystic character, may have pulsation communicated to them from a neighboring artery; but the true pulsating tumors of bone owe their pulsations to some inherent peculiarity of structure, which appears to consist either in the development of a vascular tissue of abnormal character, or else in the simple enlargement and dilatation of the vessels of the bone. In the first and most frequent class of cases, those in which a new tissue is developed in the osseous structure, we usually find the tumor to partake of an encephaloid character; a creamy, curdy or brain-like, soft, and very vascular mass is formed as an essential principal constituent of it. This might consequently with propriety be termed an *encephalo-osteo-aneurism.* This abnormal mass will be found to present every shade of transition, from true encephaloid cancer to a purely vascular tissue of an erectile character. Billroth has described a somewhat similar condition as occurring in sarcomatous tumors of the bones of the lower extremity, in which numerous small aneurismal dilatations existed on the vessels, forming a network throughout the mass. In the second and more rare form of the disease, there is developed in the bone a structure, which originally, and in many cases throughout, is a *vascular erectile growth*, closely resembling capillary nævus in its structure, composed of an infinity of bloodvessels, interlacing in every possible way, so as to form a soft reddish-yellow tumor. In a third form, a hollow cavity is formed in the bone, scooped out of the cancellous structure and filled with blood, partly liquid and partly coagulated, and having arterial branches freely opening into it. The shell of bone surrounding this cavity is very thin and expanded, being usually absorbed at one point, where it often becomes at last perforated. This constitutes the *true aneurism of bone.*

Situation.—These various kinds of pulsatory tumor of bone have been met with in almost all parts of the body; most commonly the cancellous articular ends of the long bones, more particularly of the tibia, the radius, the humerus, and the femur, have been found affected. The pelvic bones are also not unfrequently the seats of these growths; and they have been encountered in the skull and in the ribs.

Symptoms.—In its early symptoms an osteo-aneurism closely resembles the ordinary forms of spina ventosa, being oval in shape, uniform and elastic to the touch, growing slowly, without enlargement of the veins, or discoloration of the skin; these characters it possesses in common with most other tumors of bone. The special signs by which it is individualized, however, are its pulsation and bruit; the pulsation is very distinct, superficial, and commonly of a thrilling character; in other cases it is directly impulsive, and distinctly expansive; the bruit is most usually soft and blowing, but not unfrequently harsh, loud, and whizzing. In some cases the bruit is absent, though the pulsation continue distinct; this, according to Nélaton, is most frequently the case in true osteo-aneurism. In the pulsating encephaloid form of the disease, I have heard the bruit peculiarly loud, rough, and superficial. On compressing the main artery leading to the part of the limb in which the tumor is situated, all movement and bruit commonly cease in it, and it lessens in size. By pressing upon the tumor when it is thus diminished, it will commonly be found to have a bony margin, with a central depression, more especially in those cases in which there is no encephaloid entering into its composition, the growth being apparently composed of erectile and expanded osseous tissue, filled with fluid

blood. In some cases, however, the tumor is fed by several arterial branches, which may be felt distinctly pulsating under the skin. This is more particularly the case when it occurs upon the bones of the pelvis and the scapula, and then the bruit and pulsation cannot be made to cease in it. All these signs are commonly somewhat intermittent, appearing perhaps in the earlier stages of the disease, and disappearing as it advances; or the reverse may occur, the pulsation and bruit becoming distinct as the disease increases in size, and meets with more resistance in its outward growth.

Diagnosis.—It is of considerable importance in many cases to diagnose the different forms of pulsating tumor of bone from one another; some being of a truly cancerous character, whilst others appear to consist of simple expansion of the vascular element of the bone, with atrophy of its osseous substance; and consequently the prognosis also in the two conditions is very different. The true osteo-aneurism has so many signs in common with the *pulsating encephaloid tumor* of bone, that in many cases it is almost impossible to effect the diagnosis; yet it is well to bear in mind that the malignant form of the disease is not unfrequently multiple, occurring, with pulsation and bruit, in more situations than one: thus I have seen growths of this kind, with their signs well marked, springing both from the pelvis and from the ribs. The true osteo-aneurism is met with only in the articular ends of long bones; whereas the malignant disease, though commonly occurring in these situations, is also frequently found in other parts of the body. Besides these, there are two conditions which, in many cases, will enable the surgeon to determine that the pulsating tumor is an osseous aneurism: viz., the absence of all bruit, though the pulsation be distinct, and the detection by firm pressure, after the tumor has been diminished by compressing the artery leading to it, of an osseous margin around its depressed centre.

From *ordinary aneurism* the diagnosis of osteo-aneurism is, in many cases, attended by almost insuperable difficulties. So great are these, that there are many cases on record in which the most experienced surgeons of the day have ligatured arteries for tumors that were supposed to be aneurismal, but which have turned out to be pulsating growths connected with bone. A principal point to be attended to in effecting the diagnosis is the situation of the tumor, which may occur away from the ordinary sites of aneurism, in parts of the body where there is no vessel large enough to give rise to such a disease—as, for instance, about the head of the fibula or the side of the pelvis. Then, again, its incorporation with the subjacent bone, the want of a distinctly limited and circumscribed outline, and the existence in many cases of plates of bone in the wall of the tumor—giving rise, perhaps, on pressure, to the peculiar rustling or crackling sound characteristic of expansive bony growths—will enable the surgeon to come to a conclusion as to the true nature of the tumor. In this he will be further assisted by its giving on compression a soft, doughy, or spongy feel, or appearing as a depression surrounded by an osseous margin. In many cases, also, the less impulsive character of the beat of the tumor, the peculiar shrill and tremulous whiz in the pulsation and bruit, will throw much light on the nature of the disease. But it cannot be doubted that, when tumors of this kind occur in some of the ordinary situations of aneurism, as about the brim of the pelvis, and in the popliteal space, the diagnosis is surrounded with difficulties which no amount of surgical skill or tact may be able to overcome.

From *ordinary tumors of bone*, the existence of pulsation and bruit will always suffice to distinguish the growths under consideration.

Treatment.—Incision into a pulsating tumor of bone, or any attempt to remove it without its osseous connections, is clearly contrary to the rules of good surgery; and when it has been practised, the hemorrhage has been of the most alarming and dangerous character. *Resection* has been had recourse to in some instances, as when the disease has been seated on the cranial bone, but without success. Liston, in a tumor of this kind growing from the scapula, which he called "an ossified aneurismal tumor of the subscapular artery," excised the greater portion of the bone from which it sprang; but fungous growths reappeared in the wound, by which the patient was at last exhausted. When the disease has proceeded to such an extent as to produce extensive alteration in, and destruction of, the tissue of the bone affected, *amputation* of the limb is the only resource left to the surgeon. This operation is also called for in those cases in which the disease returns after other means, such as the *ligature of the artery*, have been practised. In these cases, if

a point above the affected bone.

The result of ligature of the main artery leading to the tumor depends greatly upon the nature of the growth. When it is partly composed of encephaloid or other solid tissue, but little good can result from this proceeding—the tumor continuing to increase by an inherent growth, which will continue as long as the vitality of the limb is maintained; and we accordingly find that, in all such cases in which this operation has been practised, the progress of the tumor has either not been retarded, or, if the pulsations have been stopped, and its size lessened for a time, the activity of the symptoms has speedily returned, and amputation has been rendered necessary. When, however, the tumor has partaken more of the characters of true osteo-aneurism, then a more favorable result has followed the ligature of the main artery of the limb. In a case of this kind seated in the radius, in which Roux ligatured the brachial artery, a complete cure resulted. The same also occurred to Lallemand; and in a patient of Dupuytren's, there was no return of the disease for six years, when it recurred, and amputation became necessary. These results are sufficiently satisfactory to justify the surgeon in having recourse to the ligature, or perhaps the compression, of the main artery of the limb, in those cases in which the tumor could be ascertained not to partake of the nature of encephaloid.

CHAPTER XLVIII.

DISEASES OF JOINTS.

The various joints of the body may become the seat of inflammatory affections of an acute or chronic character; of strumous disease; or of various other morbid conditions, such as more or less permanent rigidity, or anchylosis, the formation of foreign bodies within their cavities, or their malignant degeneration, and neuralgia. In studying these various articular affections, it must be borne in mind that a joint is composed of a number of different tissues; of synovial membrane, cartilage, ligament, bone, and capsule, or investing fibrous expansion. In any one of these structures the disease may primarily begin, though eventually the morbid action often spreads to other tissues besides that which was originally involved. The merit of having been the first to point out the true mode of studying these affections in reference to the different structures in which they have originated, and to have set aside that coarse pathology which, under the general terms of "arthritis" and of "white swelling," confounded together these various diseases, is certainly due to Sir B. Brodie.

SYNOVITIS.

Inflammation of the synovial membrane, the most common perhaps of all the articular affections, may be acute, subacute, or chronic.

Causes.—Whatever form it assumes, synovitis usually results from exposure to cold, especially in rheumatic or syphilitic constitutions. In these cases it commonly happens that more joints than one are implicated at the same time; and the affected articulations are most frequently those that are most exposed by having the thinnest covering of soft parts, and by being especially subjected to transitions of temperature, such as the knees and ankles. Injuries of joints, as blows, bruises, wounds, or sprains, will also frequently occasion this inflammation; but when arising from such causes, it is usually associated with inflammation of the other textures of the articulation.

Pathology.—As uncomplicated acute synovitis is never fatal, we seldom have an opportunity of studying its pathology. It would, however, appear from the examination of joints in cases of synovitis from injury, as well as from the experiments of Richet, Bonnet, and others, who have induced traumatic synovitis in animals, that there is in the first instance an inflammatory congestion and vascu-

larity of the membrane, with loss of its peculiar satiny polish. The synovia is then increased in quantity, and becomes thin and serous, and after a time intermixed with plastic matters which are poured out with it. If the disease progress favorably, these products are more or less completely absorbed. In more rare cases, the vascularity and swelling of the synovial membrane increase, until at last it becomes so turgid and distended with blood and effused fluids, that a kind of chemosis of it results; a thin, purulent-looking fluid, composed of granular corpuscles floating in a serous liquid is poured out, and disintegration, with thinning and erosion of the cartilage, and probably complete destruction of the joint, ensues. In other cases, granulations are thrown out on the looser portions of the membrane, and, becoming injected with bloodvessels, constitute fringed and villous membranous expansions, lying upon the subjacent disintegrated and eroded cartilage.

Symptoms.—*Acute Synovitis.*—The symptoms of synovitis consist of pain and heat of the joint, with distension and fluctuation of it. If it be large and exposed, the *pain* is severe, especially at night, being greatly increased by moving or pressing upon the articulation; it is usually sharp, but when the disease occurs in rheumatic or gouty constitutions, of a gnawing character. In purulent synovitis from pyæmia, it is usually very superficial, indeed almost cutaneous. On laying the hand on the joint, this will be felt to be *hot.*

The *swelling* of the affected joint is considerable, and evidently depends on accumulation of fluid within the synovial sac, the extreme outline of which is rendered apparent by the tension to which it is subjected. Thus, in the knee, it rises up high in the thigh under the tendon of the quadriceps extensor, to the extent of three or four inches above the upper border of the patella, and in the elbow under that of the triceps. There is but little if any effusion into the surrounding tissues; and hence the outline of the joint can be distinctly felt, and *undulation* perceived in it. The limb is usually semiflexed, as giving the patient most ease, and the joint cannot be moved. The constitutional febrile disturbance is tolerably severe, especially if the affection occur in a rheumatic constitution.

Chronic Synovitis.—The disease, at first acute, may terminate in a subacute or chronic form; or, subacute at its commencement, it may fall into a chronic condition. Chronic synovitis is characterized by all the symptoms of the acute variety of the disease, but in a less severe degree. The swelling and weakness of the joint are the most conspicuous local conditions. In some cases, the swelling from accumulated serous fluid is so considerable as to constitute a true dropsy of the joint—*Hydrarthrosis.* This accumulation of fluid, partaking in various degrees of the characters of serum and synovia, is usually preceded or accompanied by evidence of synovial inflammation; but, though this generally happens, it is not invariably the case. Richet, in particular, has recorded instances from which it would appear that inflammation is not a necessary or invariable accompaniment of the affection, the synovial membrane being indeed preternaturally white, and looking as if it had been washed or soddened; and though these cases are rare, those that commonly present themselves to the surgeon being of decidedly inflammatory character, yet their occasional occurrence is sufficient to establish the existence of a passive, as well as of an inflammatory form of the disease.

The presence of an abnormal quantity of fluid in the joint is always readily perceived by its *fluctuation* and *undulation*, and by the *peculiar shape* that it communicates to the part. Thus, in the knee, which is the most common seat of this affection, the patella will be felt to float, as it were, on the subjacent liquid; and the capsule of the joint projects distinctly in three situations, viz., on each side of the ligamentum patellæ, and above that bone. In the elbow, there is a soft and fluctuating swelling on each side of the olecranon, and under the tendon of the triceps; and in the shoulder there is a general roundness and distension of the articulation. It is said that, in some cases, the distension of the joint has been so great that the synovial membrane has been ruptured, and the fluid poured forth into the surrounding areolar tissue. In these cases, however, it is probable that some destructive change in the synovial membrane preceded its rupture.

In some cases of chronic synovitis distinct *crackling* will be felt in the interior of the joint, on laying the hand over the articulation whilst it is freely moved. This appears to me to be due to the existence of plastic bands or deposits in the interior of the joint, through which the fluid is pressed by the articular movements, and thus occasions the sensation which is met with under other but similar

tendons.

Terminations.—The termination of synovitis will depend mainly on its cause. When of a simple uncomplicated character, arising as the result, perhaps, of rheumatic influences, it will in most cases terminate in complete resolution. In other instances, however, plastic matter may be thrown out, which either assumes the form of warty vegetations or concretions within the joint, or of bands stretching across its interior or incorporated with its capsule, occasioning more or less permanent stiffness. When synovitis arises from wound, it usually goes on to suppuration within the joint, with superficial erosion or disintegration of the cartilage, and eventually, if the limb be not removed, to complete disorganization of the interior of the articulation, and to more or less complete anchylosis. The same happens in the puerperal and pyæmic inflammations of joints; in which cases the morbid action commencing on the synovial membrane extends downwards to the cartilages, eventually destroying them.

The chronic or subacute synovitis and hydrarthrosis usually terminate favorably; but occasionally, more particularly in strumous constitutions, the disease runs on to suppurative destruction of the joint. This, however, is rare; yet its occurrence, in some instances, should make the surgeon careful not to confound the fluctuation of serous accumulation with that of purulent collection. In the latter instances, the symptoms of inflammation will always have preceded.

Treatment.—The treatment of synovitis depends partly on the severity of the symptoms, and partly on the cause of the disease. If a joint have been injured, and synovitis be apprehended, or indeed have commenced, no treatment will be found more efficacious than the continued application of ice in India rubber bags of sufficient size to envelope the whole of the joint. In this way the inflammation may often be checked or completely arrested, the joint being of course, kept at the same time perfectly at rest on a splint or in a sling. Should the disease have made progress, and should the ice fail in arresting it, then, if the patient be young and strong, the free and repeated application of leeches to the inflamed articulation, followed by fomentations and accompanied by perfect rest of the part on a splint, or on pillows properly arranged, will be the most useful treatment. At the same time, saline purgatives with antimony must be given, and the patient kept on a low diet.

If the disease be of a *rheumatic* character, leeches must be applied, followed by hot fomentations, and rest of the part in the elevated position; at the same time colchicum, with salines, if there be much febrile disturbance, and in combination with Dover's powder, if there be much pain at night, should be administered. In some instances, where colchicum disagrees, great benefit will result from the administration of Dover's powder and calomel, in small but frequent doses. When the disease is of *syphilitic* origin, leeches are not often required; but the application of blisters, followed by calomel and opium, will be attended with marked success.

When the synovitis is *subacute* or *chronic*, the same principles of treatment must be adopted, modified according to the intensity of the affection. In these forms of the disease, rest is perhaps the most important element in the treatment, everything else proving nugatory unless this be attended to; the limb is usually best fixed by leather splints, buckled on so that they may be removed in order to make the necessary applications to it. In these cases, repeated blisterings over the whole of the joint constitute perhaps the most useful local means that we possess; in a more advanced stage, counter-irritation by means of stimulating embrocations, together with douches, either of warm sea-water or of some of the sulphurous springs, such as those of Aix, or Barèges, will prove most useful: and when all inflammatory action has been subdued, and weakness of the joint merely is left, the joint should be properly strapped with soap-plaster, spread upon leather. Amongst the internal remedies likely to be of most service, may be mentioned the iodide of potassium, either alone, or in some bitter infusion.

In *hydrarthrosis*, rest and repeated blistering will usually promote the removal of the fluid. In addition to this, the employment of pressure and friction, with absorbent remedies, as the iodine or mercurial ointment, conjoined with the internal administration of the iodide of potassium or a mild mercurial course, will often procure the absorption of the fluid. If these means fail, we have a very powerful method of cure at our command in the injection of the joint with tincture of iodine. This plan, a sufficiently bold one, has been much employed by Jobert, Velpeau, and

Bonnet. These surgeons used the tincture diluted with two or three parts of water. A small trocar is introduced into the joint, a moderate quantity of the serous fluid is let out, but not all, and then a corresponding quantity of the iodine solution is thrown in; and after being left for a few minutes, is allowed to escape. Inflammation of the joint, which is a necessary result of this procedure, comes on. This is then treated by ordinary antiphlogistic means, and, according to the statements of the French surgeons, has in no case been followed by any serious consequences, but in several instances by a complete cure without anchylosis; a new and healthy action having been imprinted on the synovial membrane. This mode of treatment does not appear hitherto to have met with much support in this country; yet it certainly deserves a trial, though recourse should not lightly be had to it, as it is evident that the induced inflammation might exceed the expected limits. In one case of hydrarthrosis of the knee, in an old man, in which I employed it, about six ounces of thin synovia were drawn off, and a drachm of strong tincture of iodine was injected into the joint. Slight inflammation only ensued; and the disease, which was of two years' standing, was completely cured. The chief points that appear to require attention, are that no inflammation be going on at the time, there being no tenderness or pain in moving the joint, the effusion being quite passive, and of a very chronic character; and, above all, that no air be allowed to enter with the injected fluid. After dropsy of the joint has been removed, the articulation is usually left weak for some length of time, in consequence of the stretching to which its ligaments have been subjected; here cold douches and an elastic bandage will constitute the best mode of treatment.

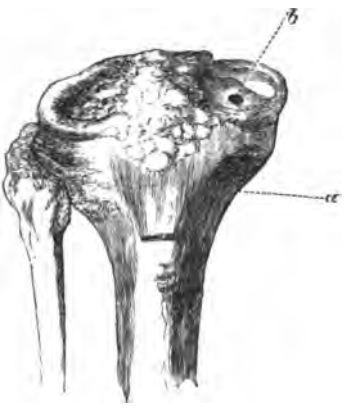
ARTHRITIS.

Simple Acute and Chronic Arthritis.—By *arthritis*, in its simple form, is meant inflammatory disease of an acute or chronic kind of the whole or greater part of the structures that enter into the formation of a joint. This affection may commence in the *synovial membranes*, and then spread to the other articular tissues; or it may begin in the *cartilages* or *bones*.

Diseased action is very seldom primarily set up in the *ligaments* of the joint; though these structures commonly become elongated, softened, and destroyed, as a consequence of other forms of articular disease. But, though primary inflammation of the ligaments is so rare an affection as to have been denied by many, yet it certainly does occasionally occur. This is especially seen in the hip-joint, where the inflammatory affection may commence in the round ligament; illustrative of which there is a very beautiful model in the University College Museum.

Inflammation may commence in the *fibrous capsule* of the joint; this we find more particularly to be the case when the affection is of a rheumatic character; in these cases inflammation, running into suppuration and slough of this structure, will commonly spread to the internal parts. In some instances, this form of disease gives rise to the deposition of masses and layers of bone in the areolar structures outside the articulation.

Causes.—In some instances, *acute necrosis of the shaft* of one of the long bones, as of the tibia, will extend to the epiphysis, and thus run on to destructive action in the terminal articulations, the cartilages becoming undermined, softened, and perforated. It not unfrequently happens that the arthritic disease is a result of a *morbid condition of the articular ends* of the long bones, or of those short bones that enter into the formation of the joint; this we especially see in diseases of the foot, of the elbow, of the knee, and hip; but it is a condition which, I believe, may occur in any joint. The bones usually become, in the first instance, the seat of tuberculous infiltration; this runs into unhealthy suppuration, which gives rise to caries and limited necrosis (Fig. 301 *a*); as the diseased action approaches the articular surface, the incrusting cartilage becomes loosened and detached, and at the same time gradually disintegrates, and becomes perforated (Fig. 301 *b*), nutrition in it being arrested or modified by the morbid state of the subjacent bone. When once the cartilage becomes affected, the whole of the interior of the joint speedily suppurates, and is destroyed. In other cases, inflammatory congestion, but without the formation of tuberculous matter, takes place in the articular ends, which become somewhat expanded; and then, without any suppuration occurring in the osseous structure, the cartilage gradually separates or peels off, and becomes



Caries of head of tibia; perforation of cartilage.

met with in disease of the tarsal articulations.

Arthritis commonly results from *wounds of joints* or *injuries*, such as sprains and fractures occurring in their vicinity, more particularly in young people, and in those of a lymphatic constitution. It also occurs as a not unfrequent accompaniment of *pyæmia* (pp. 461, 462, 467), and of some of the morbid conditions of the *puerperal state*. The puerperal inflammation of joints is of a very destructive character, most generally speedily terminating in suppurative disorganization. One or several joints may be affected, and the knee is the one that I have seen most frequently and seriously involved. Puerperal arthritis probably depends upon a purulent infection of the blood, the result of uterine phlebitis. [It would be more consonant with modern views of pathology to attribute puerperal arthritis to a septicæmic state constituting one of the varieties of puerperal fever.—A.] Arthritis not unfrequently occurs as a consequence of *scarlatina;* and I have especially seen the knee-joint affected in a destructive manner after this disease. In some forms of *albuminuria* there is also a great tendency to inflammation of the joints; and, indeed, I have so frequently seen that form of renal dropsy which follows scarlet fever accompanied by serious, sometimes destructive, inflammation of some joint, as almost to look upon one condition as the sequence of the other.

In old people, acute disorganizing arthritis is occasionally set up without any injury or other external exciting cause. I have in this way seen the joints of the foot, the ankle, and the sterno-clavicular articulation rapidly destroyed, with great local inflammatory excitement, and severe constitutional disturbance of a low form. These attacks are often mistaken in the first instance for gout; but the rapidity of the disorganizing action, the formation of pus within and around the joint, the necrosis of the contiguous bones, and the separation of the incrusting cartilages, all indicate the different nature of this affection; which, so far as the joint itself is concerned, is incurable, and which may terminate in the loss of the patient's life.

Symptoms.—The symptoms of arthritis that are most marked are the pain, heat, swelling, and peculiar position of the joint. The *pain* is often severe, tensive, and throbbing; so acute is it sometimes, that the patient screams with agony; he cannot bear the bed to be touched, the room to be shaken, or the slightest movement communicated to the limb, any attempt at examination of the joint in such cases being attended with insupportable agony. There are usually nocturnal exacerbations, and the pain is commonly referred with especial severity to one particular spot in the joint; thus it is generally felt at the inner or under side of the knee-joint, and at the outer aspect of the hip. The *heat* of the diseased joint is considerable, and is often accompanied with more or less superficial redness. The *swelling* is uniform, involving the whole of the articulation, and not projecting at certain parts of it, as when the synovial membrane alone is affected; it is generally not very considerable, and has a soft and doughy, rather than a fluctuating feel. As the disease advances, however, the swelling generally increases suddenly, and to a considerable extent, either in consequence of the irritation of the synovial membrane, or of the accumulation of pus within or around the joint. In many cases the synovial membrane gives way, and the pus from the interior of the joint becomes widely diffused through the muscular interspaces of the limb, forming enormous abscesses and long sinuous tracts. The *position* of the affected limb is peculiar, and that attitude is insensibly adopted in which the patient will have the greatest amount of ease; thus the knee is semiflexed and turned outwards, the thigh is adducted, and the elbow is bent. *Spasms* or *startings* of the limb, often of a very sharp and painful character, come on at times; more particularly at night. Just as the patient is falling off to sleep, they wake him up with a feeling of alarm, and are often very distressing. The *constitutional disturbance* is very severe, and of an actively febrile type.

As the disease progresses, *suppuration* takes place within the joint, which becomes hot and red, with a good deal of throbbing pain, and at last fluctuation is perceived

where the coverings are thinned. In some cases the suppuration occurs with very great rapidity, and luxation of the head of the bone takes place. In other cases the synovial membrane and capsule of the joint give way without any looseness of ligaments or displacement of bones, pus becomes infiltrated into the areolar tissue around the joint, an abscess forms externally to the articulation, and extensive purulent collections become diffused through the limb. As the joint becomes loosened by the destruction of its ligaments, the bones become mobile, and grate against one another where the incrusting cartilage has been removed, thus giving rise to very severe suffering. The cartilages may, however, in some cases be very extensively destroyed, and yet no grating takes place; this is owing either to the destructive action being limited to the edge of the incrusting cartilage, the opposed surfaces being sound, or else to the interior of the articulation being filled up with plastic matter after the removal of the cartilages. But though abscess, either within the joint or external to it, usually forms when the bones grate and the cartilage disintegrates, yet it occasionally happens that these conditions take place—those symptoms that are indicative of the erosion of the cartilage, such as painful startings of the limb, grating, and preternatural mobility of the joint—and yet no abscess forms; all the symptoms subsiding under proper treatment, and the joint recovering, though perhaps with a certain degree of anchylosis. But the reverse may also take place. Suppuration may take place in a joint, either as the result of pyæmia or of injury, the synovial membrane and the capsule may give way, extensive infiltration of pus into the deep areolar planes of the limb may occur, and yet no laxity of ligament, no preternatural mobility of the bones, no grating of the osseous surface, indicate the disorganization of the articulation which is in progress. This condition may occur in any joint; I have most frequently met with it in the knee. There the upper and usually the outer part of the capsule generally gives way, and the pus diffuses itself deeply through the muscles of the limb, sometimes between the periosteum and the bone even. In these cases the thigh swells greatly, the limb becomes œdematous, and a deep and obscure sensation of fluctuation may perhaps be felt, more especially towards the outer and lower part of the limb just above the knee. The swelling of the joint has perhaps subsided, giving a false idea of security, which is confirmed by the absence of signs indicative of disorganization, such as lateral mobility and grating. But, on pressing the thigh downwards, the joint will be found to fill, the patella will float again, and there is an evident communication between the interior of the synovial membrane and the extensive diffused abscess in the thigh. In cases of this kind the pus will first come to the surface about two or three inches above and to the outer side of the joint; and, on a free incision being made here, immense quantities may be let out. In these cases the fluctuation is often masked by the œdema of the limb, and by the thickness of the overlying mass of the areolar tissue and muscle, and will require the closest examination and the most practised finger for its detection. After suppuration has taken place, the constitutional disturbance partakes of the irritative type, the patient suffering severe pain, and being worn out by want of rest. Hectic may occur, and death from exhaustion and irritation, unless the diseased part be removed. In other and less severe cases it falls into a state of chronic thickening, perhaps with fistulous openings leading down to the diseased structures; and in some of the more favorable instances the patient may recover, with a permanently rigid joint.

Diagnosis.—*Abscess* may form externally to, but close upon, the capsule of a joint, and closely simulate disease of the articulation. In these cases the absence of serious constitutional disturbance, the irregularity of the swelling, greater on one side than the other, its extension over bony points, as the patella or olecranon, the superficial character of the fluctuation, the absence of all rigidity about the joint or of that preternatural mobility in a horizontal direction which arises from softening of the ligaments, and of other severe local symptoms, such as pain, starting, looseness, or grating, will enable the surgeon to effect a correct diagnosis.

Pathology.—In arthritis, the principal changes are undoubtedly found to take place in the cartilages; at the same time, it must not be supposed that all morbid appearances that are found in these structures are the result of inflammation, as erosion and absorption of their tissue may take place independently of any diseased action. The long-continued disuse of a joint, as in the treatment of fractures, may occasion this; and in old people it is very common to meet with a porcellanous or ivory-like deposit on the articular ends of the bones, which, however, does not pre-

According to Quekett, this porcellanous deposit is of two kinds: one consisting of unorganized earthy matter, the other of true bone having the Haversian canals filled with phosphate of lime.

In *acute* arthritis, the cartilages are usually found ulcerated and eroded in patches of varying size, exposing bone, which is rough and vascular. The remains of the cartilage are softened, inelastic, opaque, and thickened, and separate easily from the subjacent bone, which can be felt rough and grating. The synovial membrane is usually much thickened and very vascular; the vascularity being most distinct about those parts where the erosions and grooves in the cartilage are deepest, and often assuming a dentated or fringed appearance. In other parts, especially about the circumference of the joint, masses of plastic matter are deposited underneath and upon the synovial membrane; these are smooth and semi-transparent, having a somewhat fatty look; the ligaments are relaxed, vascular, and softened, and the interior of the joint is filled with thin, flaky, and light-colored pus. The capsule and the cellular tissue around are thickened, and either infiltrated with pus or clogged with the same kind of plastic matter that is seen in the interior of the joint. The articular end of the bone is enlarged, soft, and vascular; and in strumous cases may be the seat of tuberculous infiltration (Fig. 302).

Fig. 302.

Interior of knee disorganized by inflammation.

Nature of the Changes in Cartilage.—The changes that take place in the cartilage in this disease have excited much attention amongst surgeons, and a good deal of difference of opinion exists as to the mode in which they are induced. Many surgeons hold the doctrine that, cartilage being extravascular, the changes that take place in it are accomplished through the medium of the contiguous synovial membrane or bone, and consequently are secondary to disease of these tissues. We may, I think, conclude that this disease of cartilage may arise in three ways: 1, through the medium of the synovial membrane; 2, through the medium of the subjacent bone; and, 3, by means of changes taking place in the cartilage itself.

1. The destruction of cartilage, as the result of *synovial disease*, may best be studied in cases of wound of a joint. In these cases it will be found, if the joint be examined before complete disorganization of it has occurred, that the diseased action spreads from the synovial membrane, where it is most intense, downwards into the substance of the cartilage, which, superficially diseased, appears more healthy the deeper the examination of it is carried. Immediately under the swollen, gelatinous-looking, brightly injected synovial membrane, the cartilage will be found to be reddened, roughened, and softened. On examining a thin slice of this, it will be found to be composed of granular matter and nuclei of cells whose walls have disappeared. At a little greater depth than this it will present an opaque matrix, with cells, some perfect, others imperfect or disintegrating; and below this level we come to healthy white cartilage, with clear matrix, and well formed cells.

The disorganization of the cartilage will eventually go on to its complete removal, and to the exposure of bare and roughened bone. It is in this way that destruction of joints, as the result of punctured wounds, pyæmia, or puerperal inflammation, results.

Aston Key advocated the doctrine that a peculiar disease was set up in the synovial membrane, so as to form a fimbriated or fringed vascular network or tissue, by means of which the cartilage was absorbed; and that, as this membrane extended, so did the removal of the cartilage go on. That an appearance of this kind in inflamed joints is of common occurrence is doubtless the case; but Goodsir has shown that Key erred in attributing the disintegration of the cartilage to this membrane; for he states that a fibrous tissue forms in a diseased joint as the result of

the disintegration of the cartilage, and that this, which is connected with either the synovial or the osseous surfaces, speedily becomes vascular. So far, therefore, from being the organ by which the cartilage is removed, it is the result of prior disease in this structure. At the same time it cannot, I think, be doubted that a villous injected state of the synovial membrane will modify the nutrition of the subjacent cartilage in such a way that disintegration, erosion, and apparent ulceration of it will ensue.

2. Disease of cartilage primarily dependent on *morbid action in the subjacent bone* is, I believe, one of the most frequent modes of disorganization of joints in strumous subjects, and most certainly leads to those rapidly destructive affections of joints, in which amputation or excision is required. In these cases, either as the result of violence, or from constitutional causes, the articular ends of a bone, or the whole of a bone if it be one of the tarsal, becomes congested, inflamed, carious, or necrosed, sometimes infiltrated with tubercle. In consequence of this disorganization of the osseous tissues, the incrusting cartilage becomes detached, its under or attached surface softened, and at last perforation takes place, as in a preceding cut (Fig. 301 *b*, p. 710), taken from the tibia of a boy whose limb I amputated for acute disorganization of the knee-joint, following carious disease of the head of the tibia. This process of disintegration, and at last perforation and erosion of the cartilage, takes place in a direction from below upwards. So soon as perforation occurs, the whole of the interior of the joint becomes acutely inflamed, and suppuration is set up in it, the ligaments loosen, and complete disorganization ensues (Fig. 302). On examining the diseased patch of cartilage in cases of this kind, it will be found to correspond to the carious or tuberculous bone, from which it is separated by some bloody fluid; it will also be seen that the under edges of the erosion or perforation in the cartilage are separated to some extent from the subjacent bone, from which they readily peel off, and that they are bevelled off towards the aperture.

3. That cartilage is susceptible of *primary change of the nature of inflammation or ulceration*, induced by the action of its own vessels, is the opinion of Brodie, Mayo, and Liston, all of whom have observed true vascularization of cartilage. This condition, however, is extremely rare, and is certainly not one of the more common forms of joint-disease, seldom occurring except in the more chronic stages of arthritis.

These, however, are not the sole changes that take place in the cartilage in arthritis; the observations of Goodsir, of Rainey, and of Redfern, all point to the fact that cartilage, like other extravascular tissues, is subject to other transformations, independent of the prolongation of vessels into it. The changes that ensue are, according to Redfern, of the following kind. The cartilage-cells enlarge, become rounded, and granular looking; and, instead of their containing two or three nuclei, a considerable number are inclosed in the cell-wall; eventually these corpuscles break up, and are disintegrated. The matrix of the cartilage now softens, and, according to Redfern, splits up into fibres or bands which become nucleated. A species of fatty degeneration also, as pointed out by Rainey, takes place, and helps to soften and break down the structure of the cartilage. In the more advanced stages of disease of cartilage, masses of porcellanous deposit are found attached to the ends of the bones in plates and layers, taking the place of the eroded cartilage.

In other cases, a soft, pulpy, and vascular fibro-plastic deposit of a grayish, ashy, reddish-brown color, with whitish streaks of a firmer material running through it in various directions, takes the place of the cartilage that has been removed, or that has undergone fibro-cellular degeneration. On examination under the microscope, this will be found to be composed of plastic material, with cartilage-corpuscles intermixed, and with the subjacent bone in a state of disintegration and softening. This condition of joints I believe to be analogous to the "pulpy degeneration of the synovial membrane" of Brodie. It would appear, from the microscopical examinations that I have in various cases made of this material, to which my attention was first directed by Dr. Quain, as occurring in a patient of his whose elbow-joint I excised, that it is either fibro-cellular degeneration of the cartilage, or an imperfect attempt at repair set up in the articulation, after the removal of the cartilage by previous disintegration and disease. On making a vertical section of the surface of the diseased articulation in the case alluded to, it was found that the pulpy and villous substance covered the bone to the thickness of a line and more in some parts. The bone was found to have its cells filled with oil-globules, but surrounded by tolerably

diseased surface the laminæ and corpuscles became less distinct; and, still nearer, the cells of the bony tissue appeared to be surrounded merely by a layer of fibrous texture, in which irregular particles of bone were observed. These particles, which were elongated, irregular in form, and rounded off at the angles, were very aptly compared, by Dr. Quain, to crystals in a state of solution. At the diseased surface, the place of the cartilage and synovial membrane was occupied by a fibrous texture abounding in cells, larger than pus-cells, nucleated and spherical, containing numerous granular particles. Irregular masses of cartilage, undergoing the same process of softening as the bony particles already mentioned, appeared in this fibrous texture. The morbid appearances found in this case were so characteristic that they may be taken as the type of this peculiar morbid condition, which I have since repeatedly met with in other articulations besides the elbow, more particularly those of the finger and the knee, and which always, I believe, constitutes an incurable form of disease. I have met with this condition in instances only in which the articular affection has been of very old standing, and has fallen into a truly chronic state.

Repair.—When repair takes place in a joint, the cartilages of which have been eroded or destroyed, it is by the articular ends of the bones becoming connected, and the surface from which the cartilage has been removed filled up by fibro-cellular tissue, forming a kind of cicatricial material that leaves the joint permanently stiffened. In other cases, porcellanous deposit takes the place of the eroded cartilage; and, in some instances, the exposed osseous surfaces may grow or become soldered together, forming a permanently anchylosed and immovable state of the articulation. In no circumstances does cartilage, when once destroyed, become regenerated.

Treatment.—In the treatment of *acute* arthritis, perfect rest of the articulation is of the first moment. Unless this be secured, no other treatment can be of any avail. The limb should be comfortably supported on pillows, or laid upon a well-made and softly-padded leather splint, or slung in a cradle; at the same time blood should be freely taken away by cupping or leeching the affected part, and this local depletion must be followed by assiduous fomentations. In the acute stage of the disease, the internal remedy from which the most essential service may be derived is the calomel and opium pill (gr. ij and gr. $\frac{1}{2}$) every fourth or sixth hour, at the same time that a strict antiphlogistic regimen is persevered in. After the violence of the symptoms has been subdued, and the disease has assumed a *chronic subacute* form, some modification must be made in the treatment. In this stage *rest*, absolute and immovable, is equally indicated as in the acute stage. It may be secured in the same way. But in many cases I know no more efficient method of steadying the inflamed joint than the application of the starched bandage, the limb having been previously enveloped in a thick layer of soft wadding. The joint may be repeatedly blistered; but in many instances most benefit will be derived from the application of the actual cautery. This agent, when properly applied, yields much more certain and successful results than any other form of counter-irritation with which I am acquainted. The patient having been anæsthetized, a cauterizing iron heated to a black-red heat should be rapidly drawn over the diseased articulation in a series of parallel lines, across which an equal number of cross-bars are again drawn, so as to char, but not destroy, the true skin. A good deal of inflammatory action is thus set up, followed by slight suppuration. When this has subsided, the application of the hot iron may, if necessary, be repeated; in this way the deep gnawing pain will usually be readily removed, and suppuration of the joint may be averted. For counter-irritants to be of any use, they must be employed before suppuration has set in; I believe that it is only torturing the patient unnecessarily to have recourse to these agents when once pus has formed in the articulation. In order that full benefit should be derived from this plan of treatment, it must be persevered in steadily for a considerable length of time, and should be conjoined with a moderately antiphlogistic and alterative treatment. With this view, the bichloride of mercury, in doses of from one-sixteenth to one-twelfth of a grain, may be advantageously given with the compound decoction of sarsaparilla, or, if there be much debility, with the compound tincture of bark; good food and stimulants being conjoined with it, in proportion to the advance of the debility. In proportion as the inflammatory action about the joint subides, a tonic plan of treatment on ordinary medical principles should be substituted for that which had previously been employed.

With respect to the local treatment of the inflamed joint in the *more advanced and subacute forms* of the disease, it may be stated generally that, so long as it is tender on pressure, applied perpendicularly or laterally, so long as there is any loosening of the ligaments, or pain induced by movement, it must be kept absolutely at rest in splints, or what is better, by a starched bandage well wadded. During this period great care must be taken to keep the joint in a position most useful to the patient in after life in the event of anchylosis taking place. But every means consistent with the safety of the joint should be taken to prevent its becoming stiff. With this view, friction, douches, and passive motion should be employed; and if it be in the lower limb, slight extension by means of a weight attached to the foot may be kept up, so as to separate the articular surfaces from one another, and thus to lessen the chance of anchylosis by plastic bands. Should, unfortunately, these means fail, and suppuration take place in the joint, active steps must at once be taken to let out the pus freely and completely. If the skin covering it be reddened at any one part, the abscess should be freely opened by one or two lateral incisions, extending fairly into the joint, so as to afford a free exit for the pus.

In some cases, even when abscess has formed, the joint being perfectly loose and grating, by perseverance in proper treatment, both local and constitutional, a good and useful limb may be left; and, although there be mobility and grating, provided there be no sign of abscess, the surgeon should never despair of obtaining a satisfactory result.

The practice of making free incisions into a suppurating joint, as advocated by Gay, is a great improvement on the former method of merely puncturing it. If a small aperture only be made, air is admixed with the pus, which becomes offensive and irritating, and, being unable to escape freely, sinks to the bottom of the articulation with *débris* of the disintegrated cartilages, &c., giving rise not only to much local mischief, but to proportionate constitutional disturbance. By freely laying the joint open, all this is prevented; exit is given to the pus through one or two incisions that extend the whole length of the articulation; no constitutional disturbance can occur from pent-up and putrid matter, and the joint has a better chance of healthily granulating.

After the formation of abscess the prognosis is most unfavorable, especially when large joints, such as the knee or hip, are affected; or when those are implicated which are important to life, such as the articulations of the vertebræ; so, likewise, when the articular ends of the long bones are affected, it is seldom that the joint can recover itself, as caries or necrosis are complicating its disease and keeping it up. When the articulation is very sinuous, as in the carpus, or when a number of small joints communicate with one another, if not directly by synovial membrane, at all events indirectly through the medium of ligament and of fibrous tissue, as in the tarsus, a cure can scarcely be anticipated. In all these cases, hectic and great constitutional irritation usually come on. Pyæmia is not unfrequently developed, or, the joint becoming useless or cumbersome, its removal must be practised either by excision or amputation.

The result will at last in a great measure depend upon the state of the bones that enter into the conformation of the joint. If these be sound, or not primarily affected, and the patient's constitution has got over the effect of the occurrence of suppuration in the joint, anchylosis more or less complete may be confidently looked for. But if the articular ends of the bones be primarily or deeply implicated, then excision or amputation will be the only alleviation.

When an inflamed joint, whether it has suppurated or not, appears to be disposed to undergo a cure, its repair must be facilitated by keeping it in a proper position, such as will be most useful to the patient in after life, should it become stiff; the straight one for the knee and hip, and the semiflexed for the elbow. When the ligaments have become softened so as to admit of lateral mobility, very special attention will be required to prevent displacement of the osseous surfaces from one another, either laterally or antero-posteriorly: this may be produced partly by the weight of the limb, partly by the traction of the muscles. Any neglect of proper precautions in the more minute details of the application and adjustment of proper apparatus may be followed by a very considerable amount of deformity. Should the limb already unfortunately have assumed a faulty position in consequence of the surgeon neglecting to support it properly in splints in the early acute stage, the

position as will be most conducive to his after-comfort. It may be useful to strap the joint firmly in the proper position, in the way recommended by Scott when it is the knee that is affected, or by means of starched bandages when the hip or elbow are implicated. Scott's plan of treatment consists in spreading on pieces of lint the strong mercurial ointment, to every ounce of which a drachm of camphor has been added; strips of soap-plaster spread upon leather are then cut of a proper length and breadth, and the joint is firmly and accurately strapped up, the limb having previously been bandaged as high as the joint that is strapped. This dressing may be left on for a week or two, until it loosens or gives rise to irritation; over the whole a starched bandage may be applied. In many cases I have found it advantageous to strap up the joint with a plaster composed of equal parts of the emplastrum ammoniaci cum hydrargyro, and the emplastrum saponis or belladonnæ. These applications not only fix the joint and promote the absorption of the plastic matter that is deposited around it, but, by acting as gentle counter-irritants, remove the remains of the inflammation that may be going on within it.

[In the acute stage of arthritis, I have often found a warm poultice the most soothing local application that could be made: in the latter stages I have derived advantage from painting the joint with the tincture of iodine, compressing the part afterwards by means of a soap plaster and firm bandage.—A.]

Chronic Rheumatic Arthritis.—A disease has been described by R. Adams and R. W. Smith, of Dublin, to which the name *chronic rheumatic arthritis* has been given. It commonly affects the hip, but has been met with in the temporo-maxillary articulation, and in the shoulder. I have met with cases of disease of this joint presenting all the characters of this affection during life, though, as there has been no opportunity of examining the state of the parts after death, it is impossible to speak positively as to the true nature of the disease. Chronic rheumatic arthritis is an active disease of the bones and fibrous expansions about the joint: it is especially characterized by considerable increase in the size and by alteration in the shape of the osseous structures, which become porous in some parts, porcellanous in others; by thickening of the fibrous capsule of the joint with deposition of masses or plates of bone in it, and ultimate destruction of the cartilages and synovial membranes. The suffering is considerable; the disease greatly cripples the utility of the joint, at last produces incomplete anchylosis of it, and is incurable.

Fig. 303.

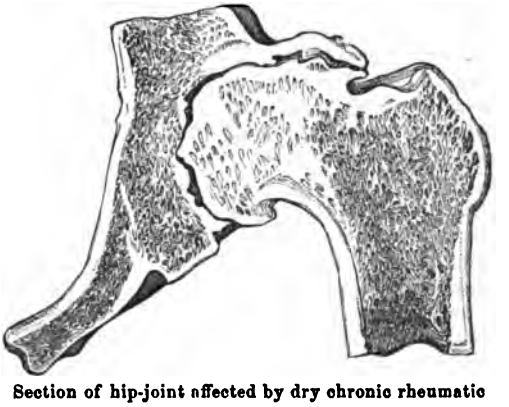
Dry chronic rheumatic arthritis of right hip-joint.

Dry chronic rheumatic arthritis of the hip.—This form of the disease commences with pain in and about the joint, increased at night, and especially in damp or cold weather, presenting in this respect the ordinary characters of a rheumatic affection; as the disease advances, the pain, which is continuous, is much increased by standing or walking, and the movements of the joint become gradually more and more impaired. The patient experiences the greatest difficulty in bending the body forwards from the hips; he consequently is unable to stoop, or to sit in the ordinary position, being obliged to keep the limb straightened in nearly a direct line with the trunk. The difficulty in walking, in standing erect, in stooping, and in sitting increases. The trochanter will be felt to be thickened, and increased breadth of bone is distinctly perceptible in this part of the thigh. The limb, at first perhaps slightly lengthened, eventually becomes shortened to the extent of about an inch or more, owing to changes that take place in the head of the bone. The pelvis also assumes an oblique direction, and hence the apparent shortening becomes considerably greater. The knee and foot are everted, and the heel is raised. The shape of the hip also alters considerably; it becomes flattened posteriorly, the gluteal muscles waste so that the fold of the nates diminishes and sinks to a lower level, but the trochanter projects more than natural, and on examination seems larger and thicker than natural (Fig. 303). On rotating the limb, it will be felt that the movements of the bone are extremely limited, and crackling, grating, or osseous

crepitation will often be felt around the joint. As Smith remarks, the lumbar vertebræ acquire great mobility, the thigh on the affected side is wasted, but the calf retains its natural size and firmness.

Pathological changes.—On examination after death, it will be found that the joint, the bones, and the surrounding parts have undergone remarkable changes. The capsular ligament is thickened, and the synovial membrane is of a bright red color, vascular, and fringed in some parts, whilst it has disappeared in others. The round ligament is destroyed, and the head of the bone denuded of membrane, the vascular fringes being attached around the neck. The head of the bone becomes remarkably altered in shape, being flattened, greatly increased in size, or placed more or less at a right angle with the shaft, sometimes elongated, and always very irregular and tuberous. The neck is more or less absorbed, and in some cases appears as if it had undergone fracture. The acetabulum generally becomes enlarged, sometimes of a more or less circular and flattened shape; in other cases, projecting at its rim, narrowed, and embracing tightly the head of the thigh-bone (Fig. 304). Both it and the upper part of the thigh-bone become porous, and perforated with numerous small foramina. Stalactitic masses of bone and porcellanous deposits are commonly thrown out about the base of the trochanter, but more particularly along the intertrochanteric line within the capsule of the joint, and not unfrequently in the soft tissue around it. In many cases the apparent increase in the size of the head of the bone is dependent on the depositions of these masses of osseous tissue upon it, rather than on any expansion or osteoporosis of the upper articular end of the thigh-bone. These masses of bone constitute one of the most important characters of the disease, and it is their presence that communicates the peculiar crackling that is felt in the hip during life. The muscles and soft structures in the vicinity of the joint are necessarily wasted, partly from disuse and partly from the pressure of the morbid masses of bone.

Fig. 304.



Section of hip-joint affected by dry chronic rheumatic arthritis.

This disease appears to be the result of malnutrition. It is not scrofulous, but occurs in persons whose health has been broken down by dyspeptic and other ailments that lead to impaired nutrition; hence it most frequently occurs amongst the poorer classes. It is most commonly met with in men. It usually occurs about the age of fifty, though sometimes earlier. I have seen several instances of it in individuals little more than thirty years of age, one of whom was a woman. It is an incurable affection, and, as it is commonly attended by much suffering, constitutes a source of great discomfort to the patient, though it is by no means dangerous to life, as the disease does not proceed to suppuration, except in very exceptional cases. In fact, the tendency is to imperfect anchylosis; and the only instances in which I have seen suppuration take place have been when it has occurred in persons of an earlier period of life than usual, from thirty to forty years of age.

Diagnosis.—It occasionally happens that individuals laboring under this affection, meeting with a fall or contusion on the hip, present signs of *fracture of the neck of the thigh-bone*, such as shortening, eversion, with some crepitation perhaps, and inability to move the limb. The diagnosis may in general readily be effected by attention to the history of the case, and by eliciting the fact, that the symptoms have existed to some degree before the accident, although the pain and immobility may have been increased by it.

In the *treatment* of this affection, little can be done to cure, but much to relieve and retard. Rest and the continued application of warm or stimulating plasters will afford relief; and, in many instances, the administration of the iodide of potassium with sarsaparilla will lessen the nocturnal pain. Smith recommends an electuary composed of guaiacum, sulphur, the bitartrate and carbonate of potass, and ginger, with a small quantity of rhubarb; and I have certainly seen benefit result

oil are both extremely useful in some cases. When the disease is once fairly established, and has assumed a very chronic character, it will be found of great importance to give the affected joint as much rest as possible, without confining the patient to the couch or house. This is best effected by his wearing a proper supporting apparatus. This should consist of a firm leather pelvic band having a steel rod extending down the outside of the limb, hinged angularly opposite the hip, knee, and ankle, and fixed into a socket in the sole of the boot, and properly adjusted by means of straps and moulded leather to the thigh and leg. By the use of this apparatus the weight of the limb is taken off, and all rotatory movement of the hip is prevented, to-and-fro motion being allowed.

Dry chronic rheumatic arthritis of the lower jaw.—Chronic rheumatic arthritis has also been described by Smith as occasionally affecting the temporo-maxillary articulation in individuals of rather advanced life. This disease is mostly symmetrical, and gives rise to an enlargement of the condyle of the jaw, which can be felt under the zygoma, attended with much pain in opening the mouth, a sensation of cracking or grating in the joint, and some enlargement of the lymphatic glands by the side of the neck. The pain is generally increased at night, and influenced by the state of the weather. The face becomes distorted, the affected side of the jaw projecting and being pushed towards the opposite side; but when both joints are affected the chin projects, the entire jaw being drawn forwards. This distortion is chiefly owing to the destruction of the articular eminence; for, when this takes place, the external pterygoid muscle draws the jaw forwards and to the opposite side; but when both articulations are equally affected, those muscles displace it directly forwards: the glenoid cavity becomes enlarged, the fibro-cartilage disappears, and the condyle is sometimes greatly thickened and flattened, and always rough, being devoid of cartilage. In such cases there is but little to be done by medicines; but the treatment must be conducted on the same principles as in the same affection attacking the hip.

Dry chronic rheumatic arthritis of the shoulder.—When it affects the shoulder, chronic rheumatic arthritis gives rise to a considerable enlargement of the head of the humerus, wasting and rigidity of the deltoid, and inability to move the elbow upwards, except by the rotation of the scapula on the trunk. In fact, the scapulo-humeral articulation being fixed, all movements of the shoulder are effected through the medium of the scapula, which becomes more mobile than natural. The articulation is the seat of much pain, lancinating at times, but generally gnawing and intermittent, being dependent on the state of the weather, and greatly increased in cold and wet seasons. The whole of the arm becomes wasted, and weakened in power. In two instances I have seen this disease in young and otherwise robust and healthy men, between twenty and thirty years of age, coming on without any apparent cause. In both cases the joint continued permanetly rigid, though the pain was relieved by the use of the iodides and by local counter-irritation.

Chronic Strumous Arthritis: White Swelling.—By *white swelling* is meant a very chronic form of arthritis occurring in scrofulous subjects.

This condition has not in many cases any definitive starting point, but appears slowly to supervene upon some slight injury, as a twist, or blow, or strain; at other times it commences with a subacute synovitis, assuming its peculiar characters by occurring in a strumous constitution, and is especially liable to happen in children and females.

Symptoms.—The disease presents peculiar characters. The affected joint is enlarged and rounded, the bony prominences being effaced by an uniform, doughy, semi-elastic, or pulpy swelling, occupying the interstices of the articulation. The integuments covering it preserve their white color: there is usually but little pain felt except in moving the limb; and the position is always that in which the patient has most ease, the joint being generally semi-flexed. There is a degree of stiffness and rigidity in the joint; and, in consequence of the wasting of the limb from disuse, the affected articulation appears more swollen than it really is. The general health does not appear at first to suffer much; but, as the disease advances, symptoms of irritation and hectic declare themselves. This affection is always characterized by a special tendency to run on to suppuration, and in the majority of cases at last passes into this condition, although the tendency may be checked by proper treatment. The joint suffers from exacerbations of intercurrent attacks of

inflammation, the limb swells and becomes œdematous, and abscess finally forms in and around the joint; often around, before it takes place within. When this is opened the constitutional symptoms become more severe, hectic speedily sets in, and strumous deposit takes place in other organs, such as the lungs, which at last carries off the patient.

Pathological changes.—In this affection the tissues immediately external to the joint, as the fibrous capsule and the investing areolar membrane, are always much thickened and infiltrated with fatty and plastic matter; and the great tendency of this gelatinous infiltration to run into unhealthy suppuration greatly adds to the mischief that ensues. In the interior of the joint, we find much the same kind of changes that have been described as characterizing acute arthritis; the cartilages have lost their polish, their elasticity, and their firm hard section, being softened, eroded, and disintegrated; the synovial membrane is removed in parts, and is here and there vascularized; in others it is replaced, together with the cartilages, either by large quantities of the semi-transparent gelatinous-looking fatty deposit, or by the pulpy gray or brownish fibro-cellular material, that are met with in arthritis. The ligaments are inflamed, softened, and destroyed, being converted into somewhat similar materials; and the interior of the joint is filled with a purulent-looking synovial fluid, thin and yellow, usually containing a large quantity of fatty matter. The bones undergo important changes in this disease, the articular ends becoming expanded and enlarged; and, though this was denied by Crowther, Russell, and others, it is affirmed by more modern surgeons, and I have had repeated opportunities of determining the fact. In all the cases that I have examined, the osseous tissue has undergone important changes, the compact structure having become thin and expanded, and the cells of the cancellated portion filled with a bloody and fatty serous fluid. The bone is softened, often cutting readily with the knife; and, owing to the deposit of fat, presents a more homogeneous section than healthy bone. In many cases, tuberculous matter is deposited in it. From this it would appear, that the principal changes that take place in a joint affected with white swelling consist in a kind of fatty degeneration of the tissues that enter into the formation of the articulation, associated with an unhealthy strumous inflammation of the parts, and in the consequent deposition of considerable quantities of semi-transparent and lowly organized plastic matter which, in its turn, has a tendency to undergo the same structural change, or to run into unhealthy suppuration.

Treatment.—In the treatment of white swelling, we must bear in mind that we have to manage a truly scrofulous inflammation and its effects. Our first object should be to prevent, if possible, the occurrence of suppuration. In the early stage, when the affection has come on insidiously, without any very active symptoms, we must trust to general antistrumous treatment; to the influence of good diet and sea-air, and to the administration of tonics, cod-liver oil, and iodine.

In the *local* treatment there are three great principles to be carried out. 1. *Rest, with perfect immobility* of the joint, is by far the most important element in the treatment, without which all the efforts of the surgeon to prevent suppuration and disorganization of the joint will be futile. 2. *Compression*, by means of bandages, strapping, or splints, will aid in the absorption of the plastic effusion in and around the joint. 3. *Counter-irritation* by means of issues, blisters, or the actual cautery, must be employed. These means, to be of real service, should be used before suppuration has occurred: after this, I believe they are of no use. The limb should be put into a position which is not only most easy to the patient, but will leave it most useful should a stiff joint result. If it be one of the joints of the lower extremity that is affected, especial care must be taken that the patient do not bear his weight on it. If the symptoms be of a rather acutely inflammatory kind, a few leeches may be applied: these, however, must be used as sparingly as possible, being confined either to the earlier stages of the disease, or to the subdual of any more active intercurrent inflammation. Rest is best secured by well padded leather or gutta-percha splints in the earlier stages; and, at a later period, by the application of the starched bandage, well lined with cotton wadding, to the limb. This kind of application will be found to give the most efficient support, and will keep the whole of the limb perfectly motionless, so that the patient can take open air exercise, and walk with the aid of crutches, without risk of injuring the diseased joint. In this respect the starched bandage presents great advantages over the short leather splints generally used. It may readily be cut open opposite the diseased

joint, so as to admit of the application of proper dressings to it. The actual cautery is extremely beneficial in these cases, applied as directed (p. 714); or caustic issues may be put in, at a little distance from the articulation, so that there may be no risk of the inflammatory action penetrating to it.

After all inflammation has, in this way, been removed, and nothing but thickening and stiffness of the joint are left, measures must be adopted for removing these conditions, and restoring the flexibility of the articulation by frictions with somewhat stimulating and counter-irritant embrocations, and eventually its strength by douches of sea water. The swelling and puffiness that are left, together with the debility dependent on relaxation of the ligaments, are perhaps best remedied by the use of Scott's strapping; but pressure should not be applied so long as there is evidence of active inflammation going on in the articulation, which it would certainly increase.

If abscess form, it must be freely opened by an incision of a proper length, the joint poulticed, and the patient's general health attended to, so as to promote the evolution of granulations, and prevent hectic. In these cases, if the limb can be preserved, its subsequent utility, and the patient's comfort, will mainly depend upon the position in which it is allowed to become anchylosed.

ANCHYLOSIS, OR STIFF JOINT.

Anchylosis is invariably the result of the destruction of a joint by inflammation, being one of the modes by which nature effects its repair. It consists in the more or less consolidation of the parts around and within the articulation. It is of two kinds: the incomplete, or fibro-cellular; and the complete, or osseous.

In the *incomplete*, or *fibro-cellular anchylosis*, the stiffness of the joint may be dependent on thickening and induration of its fibrous capsule, or on the formation of fibroid bands as the result of inflammation within the joint, or in consequence of the cartilages and synovial membrane being in part or wholly removed, and their place supplied by a fibroid or fibro-cellular tissue, by which the articular ends are tied together. The stiffness may be materially increased by the shortened and contracted state of the muscles around the joint. The incomplete, or fibrous anchylosis, is the most favorable termination that can usually be expected in chronic scrofulous affections of the joints. In some cases it arises simply from disuse: the limb becoming stiffened in the position in which it has been too long retained.

Complete or *osseous anchylosis* is of two kinds. In one, all the soft parts within the joint are destroyed, and the osseous surfaces have coalesced, or are fused together by direct bony union; this is most commonly seen in the hip, knee, and elbow (Fig. 305). In the other kind there has been fibro-cellular deposit, or degeneration within the joint; and the bones, united partly by this, are also tied together by arches or bridges of osseous matter, thrown out externally to the articulation, and stretching across from one side to the other. It has been supposed that these masses proceed from the ossification of the ligaments, or even the muscles; but, from the inequality of their appearance, it is evident that they are new and accidental formations. The true or osseous anchylosis does not occur as a consequence of scrofulous articular inflammation, but is usually the result of traumatic inflammation in persons of a healthy constitution. In the incomplete anchylosis there is always some degree of mobility, however slight, and indeed, perhaps only perceptible on deep and close examination. In the complete form of stiff joint, the articulation is perfectly rigid and immovable. It not unfrequently happens, in old standing cases of diseased joint, that more or less complete anchylosis is taking place at one part of the articulation, whilst caries or necrosis of the bones is going on at others. In such circumstances, excision or amputation will, probably, be the course to be pursued.

Fig. 305.

Complete anchylosis of hip.

Treatment.—The treatment of anchylosis is, in the first instance, of a precautionary nature: that is to say, when the surgeon finds that the establishment of anchylosis is, as it were, the natural means of cure adopted by nature in a deeply diseased joint, his efforts should be directed to taking care that the joint become anchylosed in such a position as will leave the most useful limb to the patient. Thus, if it be the hip or knee, the anchylosed joint should be in the straight position; if it be the elbow, it should be placed at a right angle, and the hand in the mid state between pronation and supination.

When once anchylosis has occurred, the treatment to be adopted will depend partly on the degree of stiffness, whether it be fibrous or osseous; and partly on the object to be attained, whether this be merely the restoration of mobility in a part anchylosed in a good position, or the remedying of the deformity occasioned by faulty anchylosis.

1. In attempting to restore the mobility of a joint anchylosed in a good position, as of a straight but stiff knee, the surgeon may usually succeed if the anchylosis be only fibrous (when some degree of movement will always be perceptible in the part), by the employment of passive motion, frictions, and douches, more particularly with warm salt water or the mineral sulphurous springs. In the more obstinate cases, and where the immobility appears to depend, in some degree at least, on fibrous bands stretching across the limb, an attempt might be made to divide these subcutaneously. In doing this no mischief can result; for, the synovial structure of the joint having been destroyed, no dangerous amount of inflammation can be set up in it.

2. When fibrous anchylosis has taken place in a faulty position—if, for instance, the knee be bent, or the elbow straight—the first thing to be done is to place the limb in such a position that it will be useful. This may most readily be done by putting the patient under the influence of chloroform, and then forcibly flexing or extending the limb as the case may require, when with loud snaps and cracks it will usually come into proper position. Should any of the tendons near the joint appear to be particularly tense, they may be divided subcutaneously. Either some days before the extension is attempted, or else if it have been carried as far as the rigid state of the tendons will permit, tenotomy may be practised, and, an interval of a few days having been allowed to elapse, extension may be completed. The inflammatory action that follows this forcible extension or flexion of the limb, is usually but very trivial; an evaporating lotion and rest will speedily subdue it. Indeed, it is surprising what an amount of violence may be inflicted on an anchylosed joint without any bad consequences ensuing. After the limb has been restored to its proper position, passive motion and frictions may tend to increase its mobility.

3. When osseous anchylosis has taken place, and the position of the limb is a good one, it will generally be wiser for the surgeon not to interfere; except in the case of the elbow-joint, which, under these circumstances, may be excised with advantage, so as to substitute a movable for an immovable articulation. If the position be faulty, the osseous union may be drilled and broken through, or a wedge-shaped piece of the bones may be taken out, and the position of the limb thus rectified.

4. Amputation may be required in cases of faulty anchylosis with so much atrophy of the limb as to render it useless, or in cases in which there is necrosed or carious bone coexisting with anchylosis and rigid atrophy of the muscles of the limb.

LOOSE CARTILAGES IN JOINTS.

It sometimes happens that in the instance of a joint the synovial membrane assumes a *warty condition*, as the result of chronic irritation of the articulation. This warty state of the membrane usually consists of flattened fibroid deposits upon its surface. In other cases these may become pedunculated, and pendant, into its interior. For this condition, which gives rise to occasional uneasiness and puffiness about the joint, with a crackling or creaking sensation when it is moved, but little can be done beyond the application of discutient plasters and the use of elastic bandages.

Loose cartilages, as they are termed, are not unfrequently met with in the different articulations. In many cases they are not truly cartilaginous, but appear to be composed of masses of condensed and indurated fibroid tissue, not very dissimilar in structure from the warty synovial membrane just referred to, and from which

forming warty growths, the pedunculated fibroid masses, and the same detached or lying loose in the interior of the joint, appear to be successive stages or conditions of the same pathological formation. Though commonly fibroid, it is probable that in some cases these bodies may be truly cartilaginous.

Characters.—These bodies vary in size from a barley-corn to a chestnut. When small, they are round; when large, they are somewhat flattened or depressed on the surface. They are smooth, shining, and usually of a yellowish or grayish-white color. They are most frequently met with in the knee; but not uncommonly occur in the elbow or the joint of the lower jaw, and occasionally in the shoulder. Most commonly only one is found; but their number may range from this up to fifty or sixty.

Symptoms.—The severity of the symptoms will to a great extent depend upon the mobility of the loose cartilage, and its consequent greater or less liability to be nipped between the opposite articular surfaces in the movements of the joint. When these bodies are tolerably firmly attached to the synovial membrane, they may merely occasion weakness of the joint, with occasional synovial effusion. When loose, they usually give rise to a very distinct train of symptoms. The most marked of these is the very severe pain which occurs in particular movements of the limb. This comes on suddenly, prevents the patient from either straightening or flexing the joint completely, and is often so intense as to cause faintness or sickness. It is usually followed by a degree of synovial inflammation, and by relaxation of the ligaments. These attacks of pain and of sudden irritability of the part come on at varying intervals, as the result of movements of it; they commonly happen in the knee whilst the patient is walking. It is difficult to say to what this severe pain is due. Richet thinks it may be owing to the synovial membrane being pinched between the foreign body and one of the articular surfaces. I think that it is most probably due to the foreign body being drawn in between the opposite surfaces of the joint, when these are separated anteriorly in the act of flexion of the knee, and then, when the limb is extended, acting as a wedge between these, tending to keep them separate and interfering with the complete straightening of the limb. In consequence of this wedge-like action of the loose cartilage the ligaments are violently stretched, and the sickening pain consequent on this act is experienced, followed, as happens in a violent sprain, by rapid synovial effusion. The sensibility of the ligaments of a joint is of that peculiar nature that it is only called into action when an attempt is made to stretch them, and thus forcibly to counteract or destroy their natural use. Ligaments may be cut without any suffering, but they cannot be stretched, either by accident or disease, without the most severe pain. In some cases the loose cartilage can be felt by carrying the finger over the joint, when it may be detected under the capsule, slipping back when pressure is exercised upon it, and often possessing great mobility, gliding from one side of the joint to the other, so as to be extremely difficult to be fixed.

Treatment.—The palliative treatment consists in supporting the joint with an elastic bandage or knee-cap, so as to limit its movements, and thus prevent the liability to the recurrence of the attacks of pain; and in this way the fixing and ultimate absorption of the cartilage may sometimes be obtained. This I have several times seen to occur in patients who either refused to be operated on, or in whom an operation was not thought advisable. Any inflammatory action that has been excited requires to be subdued by proper antiphlogistic treatment.

[Mr. Hilton strongly advises the fixation of the loose cartilage in contact with the synovial membrane by means of adhesive strips applied externally; in this way he has several times obtained complete absorption of the floating body without the risk of an operation. (*Guy's Hosp. Reports*, vol. xiii. 3d S. p. 47).—A.]

If the cartilage occasion great and frequent suffering, so as to interfere seriously with the utility of the limb, and if it appear to be of large size, and to be loose and single, means may be taken for its extraction. But it must be borne in mind that, whilst the loose cartilage is at most an inconvenience, though perhaps a serious one, any operation for its removal by which the joint is opened, becomes a source of actual danger to limb and even to life. It is far less dangerous, in fact, to leave the foreign body than to perform the operation necessary for its extraction. Hence an operation should not be lightly proposed or undertaken, without warning the patient of the possible consequences that might follow. No operation should be

undertaken so long as the joint is in an irritated state, as the result of a recent attack of pain and inflammation; this must be first subdued, and then the operation may be proceeded with; nor should it be done if the patient's health be broken. The extraction used to be effected by directing the patient in the first instance to make those movements by which he usually gets the cartilages fixed in the joint. So soon as the surgeon feels it (as this operation is commonly required in the knee), he should push it to one side of the patella, where he must fix it firmly with his forefinger and thumb; he then draws the skin covering it to one side so as to make it tense, and cuts directly down upon the cartilage by a sufficiently free incision to allow of its escape. The wound, which, when the skin is relaxed, will be somewhat valvular, is then closed by a strip of plaster, and the limb is kept at rest for a few days until it has united. Severe inflammation of the joint less frequently follows this coarse operation than might have been expected, the synovial membrane having probably undergone some modification of action that renders it little liable to the process. It has, however, happened that acute synovitis has set in, and this has terminated in suppuration of the joint, causing the patient's death, requiring amputation, or leading to anchylosis.

It has been proposed by Chassaigne, in order to obviate the dangers of direct and open wound into the joint, to remove the loose cartilage by subcutaneous section; this he accomplishes in a way that I have seen practised by Liston, and have often done myself, viz., by passing a tenotome obliquely under the skin, after fixing the foreign body in the way that has already been described, dividing the synovial membrane freely, and then squeezing the cartilage into the areolar tissue outside the joint, where it is finally fixed by plaster and bandage, and then may be left to be eventually taken up by the absorbents of the part. Goyrand recommends the same subcutaneous mode of removal of the foreign body from the inside of the joint; but, instead of leaving it to be absorbed, extracts it at the end of eight days, by a fresh incision, from the areolar tissue in which it has been lying.

A most useful modification of this method has been practised by Square, of Plymouth; it consists in fixing the loose cartilage, dividing the capsule subcutaneously over it, and then pressing the foreign body into the opening thus made, retaining it there by a compress and plasters. Adhesion speedily ensues, and the loose cartilage is eventually absorbed. In operating by this method on the knee, the cartilage should be fixed below and to the inner side of the patella, between it and the head of the tibia; a long narrow tenotome is then introduced obliquely under the skin from a distance of about two inches below the loose cartilage; the capsule of the joint is divided, the subcutaneous areolar tissue freed by a slight sweep of the blade, and the loose cartilage then pressed into the cavity thus made to receive it, where it may become absorbed. By the adoption of these subcutaneous methods there will be but very little danger of inducing undue inflammation in the joint, the entrance of air being prevented, which, and not the mere section of the capsule and synovial membrane, constitutes the chief risk. Should there be more than one loose cartilage, the operation must be repeated, but not until the inflammation induced by the former one has been subdued. In this way I have successfully removed in succession five loose cartilages from one knee.

NEURALGIA OF JOINTS.

Pain of a severe character is often experienced in or around joint, closely simulating, but not dependent upon, inflammation or other structural disease. This pain, which is purely neuralgic, may either have its origin in some local irritation of a nerve leading to the sensitive part, or it may be dependent on constitutional disorder of an hysterical character. It is this class of cases, occurring in young women who are either the subjects of hysteria, or are of a highly nervous temperament, that should especially be considered as *neuralgia of the joints*, to which the attention of the profession has principally been directed by the labors of Sir B. Brodie.

In these cases it is generally found that the hip, knee, ankle, or shoulder is the joint affected—the hip and the knee more especially. The neuralgia is usually localized in a particular joint by some slight injury that the part has sustained. But it is important to observe that in these cases the pain often does not develop itself for some days, or even weeks. after the injury that is the alleged cause of it. Severe

pain in the joint is complained of; and the limb is rendered comparatively useless, often with a good deal of distortion or contraction. On examination, it will be found that the pain, which is commonly very severe, is superficial and cutaneous, not existing in the interior of the articulation, nor increased by pressure of the articular surfaces against one another; and that it is not strictly confined to the joint, but radiates for some distance around it. This pain is often intermittent in its character, and is frequently associated with neuralgia elsewhere, as in the spine; and not unfrequently with uterine irritation or disease. At the same time, it will be observed that all the signs that ought to accompany a severe attack of inflammation in a joint, such as would be attended by a corresponding amount of pain are absent; there being no painful startings of the limb at night, no heat, redness, or swelling of it, nor constitutional fever and irritation; and the suffering being increased by causes, such as mental and emotional disturbance, that do not influence organic disease. Attention to these various circumstances will usually enable the surgeon to diagnose the nature of the attack without much difficulty; the only cases in which he will really experience any, being those in which the tissues around the joint have been thickened, indurated, and altered in their characters by the application of issues, moxæ, &c.; or by some slight articular disease having at some time existed, but having been cured.

The neuralgia is often referable to the irritation of some particular nerve, either at its origin or in its course. This is particularly the case with neuralgia of the hip and knee, which will often be found to be dependent on irritation of the obturator nerve owing to intra-pelvic inflammations, congestions, or adhesions. In one case of secondary abdominal cancer under my care, the patient was seized with the most intense pain in the right hip and knee, so to lead to the suspicion that these joints were diseased. On examination after death, it was found that the pain resulted from the implication of the obturator nerve in a mass of intra-pelvic cancer, the joints themselves being perfectly sound.

Treatment.—The treatment must be of a constitutional character, directed especially to re-establish a healthy condition of the uterine organs. If there be amenorrhœa and anæmia, aloetics and the preparations of iron must be given; if uterine irritation or ulceration exist, this must be removed by proper local means, and the general health attended to. General nervine antispasmodics and tonics, such as valerian and bark, or assafœtida and quinine in full doses, should be freely administered. The most efficient treatment that can be directed to the affected joint, is, I think, the application of cold douches and the employment of electro-magnetism, which I have found to cure cases in which all other means had failed; the application of atropine and aconite may be of service to allay the pain when especially severe. If contraction or other distortion of the limb exist, the patient should be put under chloroform, and extension or rectification of faulty position then made, care being taken to keep the limb on splints in a proper position for some time after the operation.

CHAPTER XLIX.

EXCISION OF JOINTS.

History.—The operation of resection of the articular ends of bones dates from the very earliest periods of surgery of which we have any record. Hippocrates (in his chapter on injuries of joints) speaks of resections of bones at the joints, whether of the foot, the hand, the leg, the ankle, the forearm, the wrist, as being for the most part unattended by danger, except from syncope or consecutive fever. Celsus, in speaking of compound dislocations, says, if the bare bone project it will always be an obstacle to reduction; that which protrudes should therefore be cut off. Paulus Ægineta says that, if a bone project, as after a transverse fracture, we must cut it off. Thus, it will clearly be seen that it was the practice of the ancients in compound dislocations, and in compound fractures, to resect the protruding bones. But that

the practice of resection was not unknown to them in cases of disease, is also evident from a passage on fistulæ in the works of Paulus Ægineta, who directs that, if the fistula terminate with a bone, and if that be not diseased, it should only be scraped; but if it be carious, the whole diseased portion should be cut out with chisels; and, if necessary, it may have a hole bored in it with a trephine; and a little further on he says, "the extremity of a bone near a joint, if diseased, is to be sawn off; and often, if the whole of a bone, such as the ulna, radius, tibia, or the like, be diseased, it is to be taken out entire." Nothing can probably be more explicit than this statement, in which the practice is alluded to as of frequent occurrence. But he makes exceptions in the case of the bones of the spine and pelvis, and the head of the femur, which, he says, should not be operated on for fear of the neighboring arteries.

The practice of resection thus known to and adopted by the ancients, and mentioned by the Arabian writers of the middle ages, fell completely into disuse, and seems entirely to have been forgotten until the middle of the last century, when occasional notices of its adoption appear in surgical essays. It was first employed in cases of compound fractures and dislocations of joints. In military practice, the surgeon, in two or three instances, picked out and cut away fragments of the bones forming the wrist, elbow, shoulder, and ankle-joints when shattered by gunshot. This early revival of resection involved no principle of treatment: imperfect operations being simply had recourse to on the field of battle as a matter of convenience in the particular cases in which they happened to be employed. The surgeons who performed them did not recognize any new rule of practice as being involved in these chance procedures.

The first resection practised for injury in which the articular ends in compound dislocations were fairly, deliberately, and successfully removed, appears to have occurred to Cooper of Bungay, before or at latest about the middle of the last century. The precise date of this case is unknown; but Gooch, writing in 1758, says that it occurred "many years ago;" that the ends of both tibia and fibula were sawn off in a compound luxation of the ankle; that the limb was preserved, and was so useful that the patient was able to walk and gain his livelihood.

In or about the year 1758, Wainman of Shripton sawed off the lower end of the humerus in a case of compound dislocation of the elbow-joint with perfect success, the patient recovering with an arm as movable "as if nothing had ever been amiss;" and his example was shortly afterwards followed by Tyne of Gloucester, who in a similar case removed two and a half inches of the lower end of the humerus. From this period the operation of excision of the articular ends of bones in cases of compound dislocations and fractures into joints became an established practice, and was extensively adopted by Baron Percy in France, who, in 1794, exhibited to Sabatier nine soldiers in whom he had successfully excised the head af the humerus for gunshot injury; by Belguer in Germany, and by Hey of Leeds, and by numerous other surgeons in this country and abroad.

The first case in which a methodical attempt at resection for disease of the articular end of a bone was made occurred to White of Manchester in 1768, who thus removed a large portion of the upper part of the humerus, though it is doubtful whether he actually excised the head of the bone. However this may be, he had previously satisfied himself by experiments on the dead body that this operation was practicable. Although the head of the humerus may not have been removed by White in this case, it certainly was three years later by J. Bent of Newcastle, who in 1771 excised by a formal and pre-arranged operation the carious head of the humerus with complete success. His example was followed in 1778 by Orred of Chester, who also operated successfully, in a similar case. About the same time, 1775, Justamond, surgeon to the Westminster Hospital, removed, in a case of disease of the elbow-joint, the olecranon and two inches of the ulna.

In 1762, Filkin of Northwich removed the articular ends of the femur and tibia, together with the patella, in a man affected with disease of the knee-joint, resulting from a fall from a horse. Filkin was led to this operation as a substitute for amputation of the limb, to which the patient refused to submit, in consequence of having experimentally practised it on the dead subject. The patient recovered rapidly, had a useful limb on which he was able to walk long distances, and was certainly alive nearly thirty years after the operation. This remarkable case seems to have attracted little, if any, attention, and indeed was not published until 1790, after Park of Liverpool brought before the profession his second successful case of excision of the

most successfully, as regarded utility of limb, by that surgeon in 1781, apparently without any previous knowledge of the operation that had been done by Filkin nearly twenty years previously.

The example thus set by the English surgeons was speedily followed by the Moreaus in France, who between the years 1786 and 1789, sent various memoirs to the French Academy on this subject. The operation, however, was violently opposed by the great body of surgeons, and, with the exception of the occasional removal of the head of the humerus, fell into almost complete neglect both in this country and abroad for a period of nearly forty years, during which time the records of surgery do not contain as many cases in which the articular ends of bones were excised for disease.

The operation of excision of diseased joints, though occasionally practised, continued in this languid state until 1831, when it received a new and vigorous impulse, so far as its application to diseases of the elbow was concerned, by the publication of Syme's essay on that subject, and by the practice of Liston some years subsequently at University College Hospital.

In 1845 these operations were again prominently brought before the profession by the performance of excision of the head of the femur by Fergusson; and although excision of the knee-joint had occasionally been practised by Syme, by Crampton, Textor, Demme, Heyfelder, and others, it was not until its revival in 1850 by the same accomplished surgeon, that it came to be extensively practised. Since that period the operation of excision has been applied to almost every joint within reach of the surgeon's knife.

Before proceeding to discuss the different resections in detail, we must endeavor to lay down some general rules for their performance in those cases in which they are alone admissible.

Indications for Excision.—The excision of an articulation may be practised for the following reasons:—

1. As a substitute for amputation in cases in which *the joint is so extensively diseased*, that the patient will be worn out by the discharge or pain, unless it be removed. Here a useful limb may be secured by the sacrifice of the diseased part.

2. In some cases of articular disease in which *amputation would not be justifiable*, excision may be done in order to hasten the cure, and thus to save years of suffering to the patient.

3. Excision may be done in cases in which *amputation is not practicable;* as in disease of the hip-joint or of the temporo-maxillary articulation.

4. As a substitute for other and less efficient treatment, in order *to restore the utility of a limb or joint;* as in osseous anchylosis of the elbow, or in faulty osseous anchylosis of the knee.

5. Excisions may be required in *bad compound dislocations and fractures into joints*, especially in *gunshot* injuries; more particularly in those of the head of the humerus, and of the elbow.

As a general rule, resections are more required for the diseases of the articular ends of bones than for simple disorganization of joints. If only the soft structures of a joint be involved, it usually happens that, without the necessity of resection or operation of any kind, a useful limb will result; in the upper extremity, with fair mobility of the articulation; in the lower, with more or less complete anchylosis, sufficient for a fair basis of support. But when the constitution is very strumous, or the bones are primarily or extensively affected, we can scarcely expect that the limb will recover to such an extent as to become useful.

Conditions of Success.—For resection to succeed, the following conditions appear to me to be necessary.

1. *The disease should not be too extensive*, so that its removal would entail such an amount of mutilation of the limb, as to render it less useful to the patient than an artificial member would be. This is especially important in the lower extremity. If the bones be so extensively affected as to require to be shortened by a considerable extent—for several inches—a limb would be left, which, instead of serving as a proper basis of support to the patient, would only be a useless incumbrance. In the upper extremity, length and strength are of less consequence than in the lower; the preservation of the hand is the chief thing to aim at, and if this be effected, the bones may be encroached on to a greater extent than is proper in the lower limb.

acromion and coracoid processes, where a false joint had formed. The arm was extremely useful, and all the parts below the elbow were well developed. The upper arm was two and a half inches shorter than the other. Excision of the shoulder-joint is on the whole a very successful operation, as regards life as well as limb. Hodges has collected 50 cases of excision of the head of the humerus for disease: of these, 8 died and 42 recovered from the operation. Of these 8 deaths, 3 only occurred before the third month, and 3 were from phthisis. In 2 only of the cases did the deaths appear to have been directly occasioned by the operation. In but 17 of these 50 cases was the glenoid cavity interfered with; but it is a remarkable circumstance that in no less than 7 out of the 8 fatal cases this cavity was diseased, and required either gouging, excising, or cauterization. Thus it would appear that the chance of a fatal termination is greatly increased by the implication of the glenoid cavity.

2. *Excision for compound and comminuted fracture.*—When excision of the shoulder-joint is required for compound and comminuted fracture from gunshot injury, the operation is of a less formal character. The bullet-holes must be laid freely open in a longitudinal direction, or the deltoid even cut across at its superior attachment, all loose splinters removed, and the ragged and spiculated ends of bone cut off with pliers or narrow saw; especial care being taken in manipulating towards the inner and under sides of the joint, in the vicinity of the plexus of nerves and large vessels. Without going back to the earlier cases of Percy, Larrey, and other military surgeons of the latter part of the last century, who frequently practised this operation with the happiest results, the more recent experience of the wars in Europe and America demonstrated its great utility, and that it ought invariably to be preferred to amputation at the shoulder-joint in all cases in which the large blood-vessels and nerves are intact. Hodges states that in 96 recorded cases from all sources there were 25 deaths, or a mortality of 26 per cent. But in the Crimean war the result was much more satisfactory. Thus Baudens relates 14 cases occurring in the Crimea, with only 1 death; and in the British army, of 14 cases, 12 recovered; whilst of 60 amputations at the shoulder-joint 19 were fatal.

Excision of the Scapula, partial or complete, may be required for caries, necrosis, or tumor of that bone. Caries and necrosis do not very commonly affect the scapula primarily. When the bone becomes the seat of these diseases, it will generally be found that the acromion and the spine are the parts affected. In such cases the progress of disease is usually very slow, and it will generally be found that the carious bone may be effectually gouged out, or the sequestrum extracted, by laying open sinuses, and thus exposing by irregular and informal operations the diseased osseous surface. The whole bone has, however, become affected by necrosis, dry caries, and chronic inflammation to an incurable extent. In two instances the whole bone has been excised for disease of this kind following amputation at the shoulder-joint for caries of the humerus. The operators were Rigaud of Strasburg, and Fergusson. Both cases did well.

The preservation of the arm after removal of the scapula is a matter of very considerable importance. The surgeon who first ventured on the bold operation of *removal of the whole scapula* was Cumming, in 1808. Gaetani Bey, in 1830, first amputated the arm and then proceeded to extirpate the shoulder-blade. In 1819 Liston removed the whole of the upper two-thirds of the scapula from a lad without sacrificing the arm. In 1828 Luke removed nearly the whole of the scapula from a girl of fourteen for malignant disease, sawing across the bone through its neck and the root of the acromion, and thus leaving the glenoid cavity and the acromion process. Hayman, Janson, Wützer, and Textor have all performed similar operations, removing the greater part of the bone, but leaving the glenoid cavity and more or less of the parts above the spine. In 1837 Mussey (U. S.) excised the whole of the scapula and the clavicle for an enormous osteo-sarcoma; the patient, a man, was, according to Gross, in excellent health fifteen years after this operation. In 1850 Gross removed the whole of the scapula, with the exception of the glenoid cavity, by sawing through the neck of the bone, for an osteo-sarcoma weighing seven pounds. Indeed, the American surgeons have distinguished themselves highly in this department of surgery. Thus, in 1838, McClellan removed the whole of the scapula with the clavicle for encephaloid disease, but the patient died. In two cases Gilbert (U. S.) removed the scapula, half of the clavicle, and the upper

extremity, one patient living a week, the other three months, after the operation. In 1845 Mussey successfully operated by the removal of the scapula, the outer half of the clavicle, and the upper extremity. In the case of Gross, the only portion of the scapula left attached to the upper extremity was the glenoid cavity. In 1856 Syme went a step further in this direction, and, by disarticulating the bone instead of sawing through its neck, removed the scapula with all its processes entire from a woman seventy years of age, also leaving the arm untouched. Since that period complete removal of the scapula, leaving the arm untouched, has been done several times by Syme, Jones of Jersey, Cock, Fergusson, Pollock, and others. The arm so left becomes a useful member, capable of performing all the underhanded movements and of lifting considerable weights, and it may now be looked upon as an established rule in surgery that it should never be disarticulated unless it be the seat also of disease, rendering that addition to the operation of excision of the scapula necessary. Fergusson prefers sawing through the root of the acromion to disarticulating that process, so as to give greater roundness to the shoulder and to preserve the attachment of the trapezius.

[Dr. Stephen Rogers, of New York, has in an elaborate paper collected 56 cases of excision of the whole or greater part of the scapula, and has shown conclusively that the results of the operation, both as to life and the utility of the preserved limb, are very favorable. The whole scapula should be removed in cases of malignant disease, but under other circumstances a partial excision may often be preferable. (*Am. Journ. Med. Sciences*, October, 1868, pp. 359–380.)—A.]

Partial excision of the scapula has usually been practised for tumors of that bone. The extent of bone requiring excision will necessarily vary greatly according to the size and character of the tumor, and the severity of the operation will mainly depend upon whether it is the upper or the lower portion of the bone that is the seat of disease. When the tumor is formed of a fibroid or osseous structure and situated towards the lower angle of the bone, it may be exposed by a crucial or T-shaped incision, and the body of the bone sawn through transversely below its neck and spine. In such cases the hemorrhage need not be very great, as the main trunk of the subscapular artery, or even the dorsal artery of the scapula, is not necessarily divided. If the tumor spring from and be connected with the spine and acromion, only projecting forwards over the shoulder and leaving the rest of the bone sound and the joint unaffected, it may be freely exposed, the spine of the scapula sawn or cut across with pliers, and the mass turned off from the point of the shoulder, without injury to the articulation or the implication of vessels of any importance.

When the tumor occupies the upper half of the scapula, the case assumes a much more formidable aspect, and the line of practice to be adopted must depend upon the parts involved. If it involve the body of the bone, encroaching upon the supra or infra-spinous fossa, extending forwards into the axilla below the neck of the scapula, and thus coming into relation with the subscapular artery, it would be wiser to remove the whole bone than to attempt the resection of the upper half, leaving only the lower angle, which would be useless to the patient.

When the body of the scapula is involved in a morbid growth, extending over the greater part or whole of the subscapular or infra-spinous region, and stretching forwards under the latissimus dorsi muscle into the axilla, the case becomes infinitely more serious, as not only must the whole of the scapula be removed, but the subscapular artery must be divided, and the axillary plexus of nerves and vessels brought into the field of operation. In these cases, also, the question as to the preservation or removal of the arm has to be considered. Whenever the joint is sound and the upper part of the limb free from disease, it should be preserved; and, as these conditions usually exist where the disease originates in the scapula, the contemporaneous or antecedent amputation of the arm is seldom required.

Operation.—Excision of the scapula may be performed by exposing the bone freely by means of crucial or T incisions, extending from the acromial end of the clavicle across the body and to the lower angle of the scapula. The flaps thus formed are then dissected up and turned back, the acromio-clavicular articulation, the clavicle itself, or the base of the acromion, is then to be cut through, the shoulder-joint opened, and the muscles attached to the coracoid process divided. The surgeon may now adopt one of two courses: either dissecting at once down into the axilla, dividing and securing the subscapular artery; or, leaving that which is the most dangerous part of the operation to the last, he may cut across the muscles attached

it forwards, then complete the division of its axillary attachments, thus reserving the most critical stage of the operation to the last, and having the bone more fully exposed and more completely under control than when the opposite course is pursued and the operation commenced at the axillary border. In this operation the hemorrhage is necessarily copious, and may be dangerous. In one of the earliest cases of removal of a portion of the scapula, in which Liston removed the upper part of that bone for a vascular tumor, the bleeding was frightful, and was only arrested by most energetic measures.

In all cases in which the whole of the scapula is removed, the hemorrhage must necessarily be considerable. The supra-scapular and posterio-scapular arteries bleed freely, but the hemorrhage from them and their branches is readily enough arrested. The critical part of the operation consists in the division of the subscapular artery. This should be reserved for the last part of the operation; as the vessel is cut it should immediately be seized by an assistant and tied at once.

The after-dressing of the large wound left is simple, and is to be conducted on ordinary principles, the flaps being laid down and retained by a few points of suture.

Result.—The result of the operation is satisfactory, by far the larger proportion of patients on whom it has been practised having made quick recoveries from the operation, even though some have succumbed at an early period to a recurrence of the disease for which it was practised. Indeed, the danger is much less than might at first be supposed from an operation of such magnitude.

Clavicle.—The clavicle may require to be partially or wholly excised. In caries or necrosis of this bone, portions of it may be gouged away or extracted without much difficulty, the bone being rarely affected through its whole thickness, and its posterior part consequently not requiring removal; but when, in consequence of the growth of tumors, the removal of the whole or greater part of the bone is required, the operation is one of the most hazardous in surgery, as a glance at the anatomy of the parts lying beneath the bone, and encroached upon by the morbid growth, will indicate. In 1828 Mott excised the clavicle for an osteo-sarcoma which measured four inches in diameter. This operation was one of great difficulty; it occupied four hours in its performance, and forty ligatures were required to restrain the hemorrhage. The subclavian vein, thoracic duct, and phrenic nerve were exposed, but the patient made a good recovery and was alive many years after the operation had been performed. Similar operations, but not perhaps of quite so formidable a character, have been performed by Warren, Travers, Curtis of Chicago, Cooper of San Franciso, and other surgeons. It is obviously impossible to lay down definite rules for the performance of an operation in which the circumstances must vary so greatly in each case as in this, and for the safe conduct of which the surgeon must be mainly indebted to his anatomical knowledge. It may be stated generally that the bone requires to be exposed by a free incision along its whole length: it is then sawn across or disarticulated at its acromial articulation, and carefully dissected out in a direction from without inwards, the sternal end being forcibly twisted outwards, and its ligamentous connections carefully divided, care being taken to preserve the important vascular and nervous structures in the lower posterior cervical region, and to prevent the entry of air into any cut vein by the ligature of the vessel before its division. The sternal end only of the clavicle has been excised by Davie of Bungay, in a case in which dislocation backwards had resulted from deformity of the spine, and the luxated end, gradually pressing upon the œsophagus, threatened the life of the patient. The bone was cut through by means of a Hey's saw about an inch from its sternal end, and, the sterno-clavicular ligaments having been divided, the portion of bone was forcibly elevated, and at last extracted.

Elbow-Joint.—In tracing the history of the introduction of excision of the elbow-joint into surgical practice, we find, as is the case in several other parts, that it was first partially and then wholly done for injury, and proposed by one surgeon and eventually practised by another for disease.

Thus, in 1758 or 59, Wainman, in a case of compound dislocation of the joint, sawed off the lower end of the humerus just above the fossa, leaving the patient with a flexible and useful arm. Tyne, of Gloucester, did the same, removing two and a half inches of the lower end of the humerus, in a case of compound dislocation. Justamond, of the Westminster Hospital, was the first to operate in a case of disease: this he did in 1775, removing the olecranon and 2 inches of the ulna.

Park proposed, but did not have an opportunity of practising, the complete extirpation of the joint. This was done for the first time by Moreau, senior, in 1794, and again by Moreau, junior, in 1797. Little was done from this time until the operation was revived by the surgeons of Leeds; in 1818 by Stansfield, in 1819 by Chorley and Hey. It then made rapid progress in professional estimation, and was specially largely practised by Syme and Liston, and the surgeons of the Edinburgh Infirmary. The excision of the elbow-joint has been more frequently practised than that of any other of the articulations, and the result has upon the whole been far more satisfactory.

This operatiom may be required, 1, for chronic disease of the joint; 2, for osseous anchylosis; and 3, for compound fractures and dislocations.

1. In cases in which the elbow-joint requires to be excised for *strumous disease* in young persons, it will generally be found that, after morbid action has existed for a considerable time in the joint, the limb will have become useless, and the soft parts around the joint swollen, spongy, and perforated by fistulous openings. When disease of this joint occurs in the middle-aged adult, the mischief will usually be found to be principally seated in the bones, the articular structures being only secondarily involved. In these cases there will often be very little external evidence of mischief, merely one or two fistulous apertures leading down to carious or necrosed bone in the condyles or the olecranon, the joint being permanently flexed and swollen, and the arm so useless that it cannot support the weight of the hand. On exposing the articulation, perhaps caries, with complete destruction of the cartilage, with or without necrosis of the articular ends, and with loose pieces of dead bone lying in the cavity of the olecranon, or in one of the condyles, may be found. Most commonly the radius is the last bone that is affected, the ulna and the articular end of the humerus being generally first diseased.

2. If *osseous anchylosis* have occurred, whether in the straight or with bent position, excision or simple division of a portion of the consolidated bone may advantageously be practised. This operation was first done in 1827, by Rhea Barton, of Philadelphia. When the elbow is anchylosed in the straight position, the arm is quite useless; and any operation by which flexion of the limb can be obtained, even without mobility of the joint, will add most materially to the patient's comfort, rendering the hand available for most purposes of life. In cases of *angular* osseous anchylosis of the elbow, the bony union should be sawn across or a wedge-shaped piece removed, so that a useful and movable articulation may be substituted for one that is rigid and fixed.

3. In cases of *compound fracture or dislocation* of the elbow-joint, more or less complete resection of the protruding, and possibly splintered fragments, may be required (pp. 264 and 310).

Operation.—Excision of the elbow-joint may be performed by three different procedures, viz., the H, the ⊢-shaped, or the simple longitudinal incision. Each method has its advocates. The H-shaped operation consists in making an incision parallel to, and a little to the radial side of, the ulnar nerve, another along the outer side of the joint, and uniting the two by a cross cut, dissecting up and down two square flaps, and clearing the bones laterally. It was soon found by surgeons that by this method a very unnecessary amount of incision was practised; and accordingly the vertical cut along the outer side was dispensed with, and the ⊢-shaped operation necessarily adopted. This consists in making the longitudinal incision parallel to, and a little to the radial side of the ulnar nerve, and the cross cut over the olecranon to the outer side of the joint. More recently still, it has been found that this incision may be still further simplified, and that the cross cut may be entirely done away with, and the operation reduced to a single longitudinal incision carried nearly over the centre of this joint in the middle line from above downwards. In comparing these different methods of operating, I decidedly give the preference to the single longitudinal incision, as being quite sufficient in all ordinary cases for the complete and easy removal of the articulation. Should the soft structures towards the outer side of the joint not yield sufficiently, a cross cut can at once be made, so as to liberate these, and give the surgeon more room, by turning up the two triangular flaps that will thus be formed.

The following is a detail of the successive steps of the operation as practised by the ⊢-shaped or the single longitudinal incision. The patient having been laid prone, the perpendicular cut should be made parallel to, and a line or two to the other side of, the ulnar nerve; being commenced at least two inches above the point

incision may then, if necessary, be made directly across the end of the olecranon, to the outer side of the joint, and extended as far as the extremity of the outer condyle (Fig. 310). The two triangular flaps thus made must be dissected up, the knife being carried close to the bones (Fig. 311). Or the transverse incision may

Fig. 310.

Excision of elbow-joint: ⊢ -shaped incision.

Fig. 311.

Excision of elbow by ⊢ -shaped incision. Bones exposed. Ulnar nerve indistinctly seen.

Fig. 312.

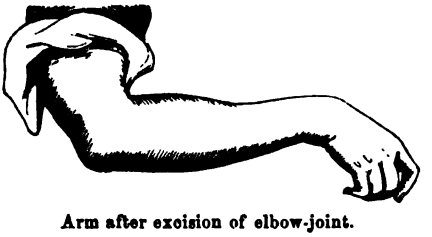
Excision of elbow-joint by longitudinal incision.

be dispensed with, and the bones readily exposed and turned out by the third method, that of the single perpendicular incision. (Fig. 312). This must be of sufficient length to allow of the sides being held well apart, and then it constitutes the simplest plan of excising the elbow that can well be devised. After the bones have been fairly exposed, they must be cleared to the inner side of the joint. In carrying the incision in this direction, the edge of the knife should always be kept against the bones, and their sinuosities closely followed, so that the ulnar nerve, being dissected out from behind the inner condyle, may escape injury. If the incision be properly planned, and the knife kept in contact with the bone, the nerve ought not to be exposed during the operation, more particularly as it is usually imbedded in a quantity of plastic tissue. When the posterior part of the joint has been laid bare in this way, the knife should be carried round the tip of the olecranon, and this process removed with cutting pliers. By forcibly bending the joint, pushing the forearm upwards, and lightly touching the ligaments with the point of the knife, the interior of the articulation will be fully exposed. By means of a small narrow saw, the articular end of the humerus is separated from the rest of the bone; the upper end of the ulna and the head of the radius may either be removed in the same way, or by means of cutting pliers. There is never any necessity to place a spatula before the bones, as the parts of importance anterior to the joint could not easily be wounded, being completely protected by the brachialis anticus. The ulnar nerve will occasionally, however, be in some danger, and it must be guarded or drawn on one side by a bent copper spatula. In this operation it is of great consequence, so far as the after-utility of the arm is concerned, not to remove more of the bones lengthwise than is absolutely necessary; the shaft of the humerus, for instance, should never be encroached upon, but it will be quite sufficient to limit the excision to the articular surface; should any carious portions of bone extend beyond this, I think it is better to scoop them out with the gouge than to remove them in any other way. The excision of the ulna and radius should not be carried so low as to divide the insertions of the brachialis anticus and biceps. After opening the articulation, a practical question of considerable importance often arises, viz., to what extent the resection of the articular ends should be carried. If they be all diseased, there can of course be no doubt as to the propriety of removing the ends of the three bones. So, also, if the humerus and ulna be diseased, the head of the radius should be cut off on a level with the section of the ulna. But the important point is, whether, in the

event of only one being implicated, by disease or injury, the surgeon should limit himself to the excision of this alone, or should remove the other two. Formerly, in accordance with the principle of conservative surgery, that diseased or injured parts alone should be sacrificed, I have advocated leaving the healthy articular ends, and only removing that which was diseased; but increasing experience has convinced me that this practice is erroneous, and that, if the joint be only partially excised, anchylosis is more apt to ensue than when the whole of the three articular ends are extirpated. I would therefore advise that, in cases of caries involving the elbow-joint, the whole of the articulation be removed, as well as in those cases in which operation is required in consequence of comminuted and compound fracture of only one of the bones; as, for instance, when the lower epiphysis of the humerus, or the upper end of the ulna only, is the seat of such injury.

In some instances no vessels require ligature, though there may be free general oozing; but most commonly one or two must be tied. In several cases, it is said, the bleeding has proved extremely troublesome. This, however, I have never seen. After the operation, the limb should be laid upon pillows, nearly in the extended position, so that the cut portions of bones may be in close approximation with one another. If the excision have been practised through a single straight incision, there will be but little if any gaping of the wound, the flaps falling closely together. If any transverse cuts have been practised, the edges cannot so readily be brought into apposition. At the end of a week or ten days, when granulations have sprung up, the arm may be put on a slightly bent leather splint, and, as the healing process goes on, this may gradually be flexed, until at last it is brought to a right angle. The fibrous union that takes place between the bones will be closer, and a more compact and useful false joint will form, than if the osseous surfaces be too widely separated in the first instance, and be allowed to unite by a lengthened ligamentous tissue. Until the contraction of the cicatrix has fully taken place, and the neighboring tissues are quite firm, the joint should be supported by one lateral leather splint on the inner side of the arm. The splint should then be removed, the arm put in a sling, and passive motion had recourse to, in order to prevent osseous anchylosis. Should there appear to be, as sometimes happens in children, a special tendency to this, the limb may be laid, before cicatrization has taken place, upon a splint jointed opposite the elbow. Much of the success in the result of excision of this, as of other joints, will depend upon the care and attention bestowed on the after-treatment of the case. The position of the parts and the relation of the bones to one another should be scrupulously attended to, bagging of matter prevented, and exuberant granulations repressed. At the same time, the patient's strength must be kept up by constant attention to diet, fresh air, &c. In this way good ligamentous union will take place. In two cases which I have had the opportunity of dissecting, one sixteen months and the other two years and a half after the operation, it was found that the ends of the bones were rounded and firmly united by a dense fibroid or ligamentous structure. In this way a most excellent and useful limb will result, having the four movements of flexion, extension, pronation, and supination nearly perfect, with but little deformity, as may be seen by the accompanying cut (Fig. 313), which was taken nearly two years after operation from a patient of mine. A coachman, whose elbow-joint I excised, was able to drive, to lift a pail of water, and to do all the duties of his employment, nearly as well as if the arm had been left in its normal condition.

Fig. 313.



Arm after excision of elbow-joint.

Should recurrence of disease take place, resection may be again resorted to with success. In one case, indeed, which had been unsuccessfully operated on twice by other surgeons, I excised the bones about the elbow for the third time with complete success, removing a considerable portion, nearly three inches, of the necrosed shaft of the humerus, and the carious upper ends of the radius and ulna. In this case, which was that of a boy about fourteen years of age, complete recovery took place. He had a most useful arm, regaining the four movements of the joint, pronation, supination, flexion, and extension, and this notwithstanding his being of a most

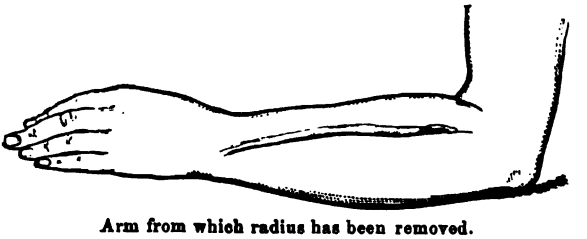
strumous habit of body. Six months after the excision he was obliged to have one thigh amputated for disease of the bone, and he eventually died at the end of two and a half years, of caries of the spine.

Results.—Excision of the elbow-joint, so far as life is concerned, is a very successful operation. The result, when it is practised for compound fracture, or dislocation, has been already stated at pp. 264, 310. When practised for disease it is equally satisfactory, and indeed death can only occur from some unforeseen and accidental complication, such as may and does follow any operation. I have lost only one patient out of eighteen in whom I have excised the elbow-joint. The principal danger after this operation arises from diffuse suppuration of the medullary canal of the humerus. I have seen this happen in two fatal cases in the practice of others, phlebitis and pyæmia developing themselves in a secondary manner in both instances; and in a third, in which the patient lost his life, it is probable that death, which was attributed to pneumonia, remotely occurred from the same cause.

The result, so far as utility of limb is concerned, is equally satisfactory. If proper care be paid to the after-treatment, a strong arm, useful for all the purposes of life, with a movable articulation, will be left, admitting of the four normal movements of the joint, viz., flexion, extension, pronation, and supination. If the whole of the articular ends be excised, and if passive motion be employed, or the limb be kept suspended in a sling merely without splints after a few weeks have elapsed, anchylosis will but very rarely take place. Should there be danger of this occurrence, the patient should be put under chloroform, and forcible flexion and extension employed, or the limb placed on a splint with a hinge-joint and rachet apparatus, which will admit of its being moved daily by the surgeon; care being taken that it be kept flexed rather than extended. Undue mobility is of but rare occurrence; I have never seen it follow excision for disease, but have met with it in one case—that of a young woman, the lower end of whose humerus was completely disorganized by a fall, and the elbow-joint opened. In this case the lower epiphysis of the humerus was excised, together with the articular ends of the ulna and radius. A good recovery took place; but, although every care was taken to support the limb on splints, a very movable joint was left. This I attributed to the whole of the lower epiphysis of the humerus having been extirpated, and the union taking place between its shaft and the bones of the forearm in an imperfect manner.

Ulna or **Radius.**—One or other of the bones of the forearm has occasionally been excised with advantage, leaving a sufficiently useful limb with good power in the hand. Carnochan of New York and Jones of Jersey have successfully excised the whole ulna. Butt of Virginia has removed the whole radius. [This is a mistake; Dr. Butt excised the lower part of the ulna; the patient recovering with a very useful arm. (*Phila. Journ. Med. and Phys. Sciences*, May, 1825, p. 115.) Dr. Compton of New Orleans has excised at one operation the entire ulna and the greater portion of the radius. I have myself on two occasions excised considerable portions of the radius in cases of gunshot fracture, one being a primary and the other a secondary operation. Both patients recovered.—A.] In a woman who was under my care about twelve years ago, I also resected successfully the whole radius, with the exception of its articular head, which was sound (Fig. 315); and a useful arm, of which the annexed figure is a good representation, was left (Fig. 314). After a time the hand gradually inclines towards the radial side of the arm; but, although the articulation between it and the forearm is but a slender one, through the medium of the ulna, a very useful member will be left. These operations do not require any specific rules for their performance; the bone is exposed by a long incision in the direction of, and made by slitting up,

Fig. 314.



Arm from which radius has been removed.

Fig. 315.

The radius after removal.

the sinuses that burrow amongst the muscles, and is then carefully dissected out from the parts amongst which it lies; especial care being taken to preserve the periosteum and any new bony deposits that may already have formed. In one case in which the elbow-joint was involved, and the radius diseased, instead of amputating the limb I obtained an excellent result by the excision of the articulation as well as of the affected bone. The patient, a builder about thirty years of age, was able, four years after the operation, to use his hand not only in all the ordinary purposes of life, but also in his trade.

Wrist.—Excision of the wrist is not an operation that has hitherto found much favor with surgeons. Most commonly, when the carpus is diseased, the morbid action rapidly extends, with constitutional irritation, to all the small bones that enter into its formation; and although in some cases a few of these may have been successfully taken away, yet methodical excision of the whole of the joint has not been followed by very satisfactory results, having either been attended by persistence of the disease in the soft parts, or followed by a stiff and useless hand and arm. A great objection to excision of the wrist consists in the superficial character of the articulation, and its close connection with the flexor and extensor tendons; hence, when the wound cicatrizes, consolidation of these and of their sheaths is apt to result, and loss of that utility of hand, the preservation of which should be the great object in the performance of the operation, is entailed. I have had a case, however (1858), in the person of a middle-aged man, in whom the whole of the carpus and a portion of the bases of the metacarpal bones were removed, and who recovered with a very useful hand, with some power of flexing and extending the wrist, and with very considerable mobility of the fingers. This case is, however, an exception to the general rule, as, in the majority of the few instances in which the operation has been done of late years, either a useless hand has been left, or secondary amputation has been required.

Lister's Operation.—From the result of two cases of severe injury to the wrist-joint, which recovered with useful hands, Lister was led to the conclusion that with proper after-treatment, the tendons about the wrist might be very freely handled without permanent stiffness necessarily resulting. At the same time, he hoped by

Fig. 316.

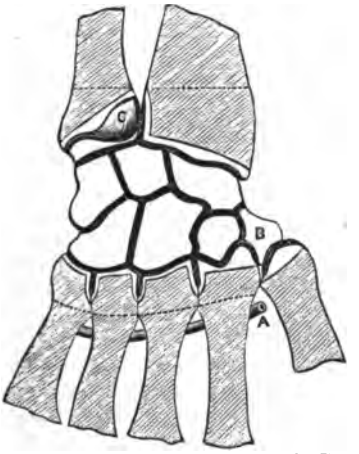
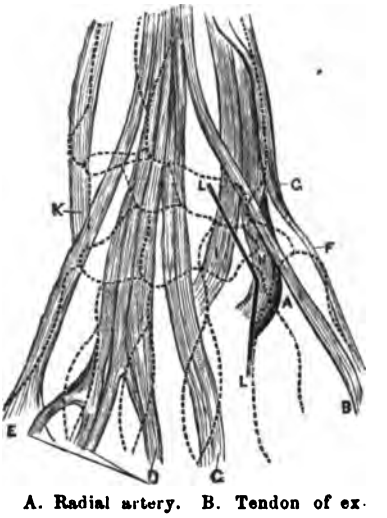


Diagram of wrist. A. Deep palmar arch. B. Trapezium. C. Articular surface of ulna over which radius moves (Lister).

Fig. 317.



A. Radial artery. B. Tendon of extensor secundi internodii pollicis. C. Indicator. D. Extensor communis digitorum. E. Extensor minimi digiti. F. Extensor primi internodii pollicis. G. Extensor ossis metacarpi pollicis. H. Extensor carpi radialis longior. I. Extensor carpi radialis brevior. K. Extensor carpi ulnaris. L L. Line of radial incision (Lister).

removing the whole of the cartilaginous surfaces to be able to prevent recurrence of the disease—which is the common ending of cases of partial excision of the wrist-joint for caries of the carpus. At the time when he published his papers, he had had fifteen cases of excision of the wrist. The method of operating was essentially the same in all; various small details being altered as experience suggested. The operation, as he

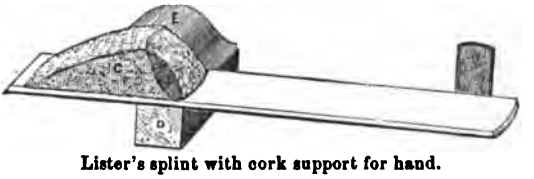
now performs it, is done as follows. Before commencing, a tourniquet is put on, as without it the oozing of blood interferes considerably with the comfort of the operator. Any adhesions of the tendons then existing may be forcibly broken down by moving the joints. An incision is then made "from about the middle of the dorsal aspect of the radius, on a level with the styloid process, downwards and outwards towards the inner side of the metacarpo-phalangeal articulation of the thumb, but, on reaching the line of the radial border of the metacarpal bone of the index finger, it is carried downwards longitudinally for half the length of that bone." This incision, if properly made, should commence in the angle formed by the tendons of the common extensor of the fingers and the extensor secundi internodii pollicis, and the upper part should run parallel to the latter tendon, but without injuring it. The tendon of the extensor carpi radialis brevior should be cut, but that of the longior should escape, and the angle formed by the two parts of the incision should be close to the inner side of its insertion. If the first part of the incision be carried too far, there is danger of wounding the radial artery. The soft parts are then to be separated carefully from the bones on the radial side of the incision, the tendon of the extensor carpi radialis longior being cut as close to its insertion as possible. The tendon of the extensor secundi internodii pollicis and the radial artery are to be pushed outwards out of the way. The trapezium must then be separated from the rest of the carpus by cutting in the longitudinal part of the incision with the bone-forceps. The soft parts on the ulnar side of the radial incision are now to be dissected up as far as can be conveniently done, the remainder being raised from the ulnar incision. While this is being done, the tendons must be relaxed by extending the joint. The trapezium is not to be removed yet, as any attempt to dissect it out before removing the rest of the carpus would endanger the radial artery and the tendon of the flexor carpi radialis. The ulnar incision is now to be made. It must be a free incision, commencing at least two inches above the end of the ulna and immediately anterior to the bone, and carried directly downwards between the flexor carpi ulnaris and the ulna, and then straight on as far as the middle of the palmar aspect of the fifth metacarpal bone. The tendons and soft parts on the dorsum of the carpus are now to be completely raised. In doing this the tendons must be relaxed, and they are to be raised as little as possible from the radius or metacarpus. The extensor carpi ulnaris is to be cut as near its insertion as possible, and the dorsal and internal lateral ligaments may now be divided. Then the soft parts are to be raised from the palmar aspect. The knife must be carried close to the ulna, so as not to wound the artery and nerve. The pisiform bone is to be separated and left attached to the tendon of the flexor carpi ulnaris, which is not to be cut. The flexor tendons are to be raised from the metacarpal bones, but in doing this the hook of the unciform bone must be clipped off with the bone-forceps, and care must be taken not to cut below the bases of the metacarpal bones, for fear of wounding the deep palmar arch. The tendons must be relaxed during this part of the operation by flexing the wrist. The anterior ligaments can now be divided. The bone-forceps may now be introduced, first between the carpus and radius, and then between the carpus and metacarpus; by this means the whole of the carpal bones are separated from their connections (except the trapezium and the pisiform bone), and may be extracted in one mass with a larger pair of sequestrum-forceps, any bands which retain them being touched with a knife.

The ends of the radius and ulna may now be easily protruded from the ulnar wound. If on examination they be found only slightly diseased, the ulna may be sawn obliquely so as only to remove its articular surface and to leave almost the whole of the styloid process. A thin slice may be taken off the end of the radius, so as only just to remove the cartilaginous surface; and its articular surface for the ulna may be removed by cutting longitudinally with the bone-forceps. By leaving the ulna as long as possible and by saving the styloid process, the tendency to displacement to the ulnar side is somewhat counteracted. If the bones be extensively diseased, the gouge and bone-pliers must be used freely. The next step is to expose the bases of the metacarpal bones and to treat them in the same way as the radius and ulna, saving as much bone as possible, but removing all cartilaginous surfaces. The second and third are most easily protruded from the radial, and the fourth and fifth from the ulnar wound. The trapezium may then be dissected out, being held in a strong pair of forceps. In doing this care must be taken, first, not to wound the radial artery, which is in close relation with its outer side; and, secondly, not

to cut the tendon of the flexor carpi radialis which lies in its groove. When the trapezium is removed, the base of the metacarpal bone of the thumb may be pushed up and cut off with the bone-pliers. It is better to remove it, as it may suffer from recurrence of the disease, and by its removal the thumb is reduced in length to the same extent as the fingers. Lastly, the pisiform bone may be examined, and either removed entirely or its cartilaginous surface cut off as the case requires. During the operation, the only tendons necessarily divided are the extensors of the wrist. The flexor carpi radialis may escape, from its attachment being situated low on the base of the second and third metacarpal bones, and the flexor ulnaris is left attached to the pisiform bone. All the extensors of the thumb should be uninjured. All the tendons must be cut as long as possible, so that they may form new attachments in the most advantageous positions; and, in raising the flexor and extensor tendons, they must be disturbed as little as possible.

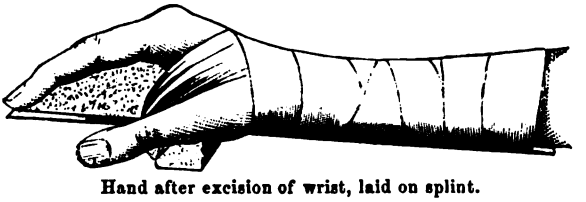
After-treatment.—The radial wound may be closely united with sutures. The ulnar wound may be closed at each end, but the middle of the wound is to be kept open by means of a plug of lint to allow free exit of discharge. The hand is to be placed on a splint. The most convenient is a simple wooden splint, "with an obtuse-angled piece of thick cork" stuck on so as to maintain the hand in a state of semi-flexion, with the wrist slightly extended (Fig. 318). The thumb is supported by a bar of cork stuck on the under surface so as to project at the side (Fig. 319). The two great objects in after-treatment are to get the fingers perfectly movable and the wrist firm. For these purposes passive motion must be commenced as early as the second day in the fingers, each being bent and extended every day fully, while the wrist is kept firmly on the splint and disturbed as little as possible during the treatment of the fingers. Pronation and supination must not be too long neglected. Passive motion must be maintained as long as there is any tendency to the formation of adhesions in the sheaths of the tendons. As the hand becomes stronger, the part of the splint supporting the fingers may be cut off. The patient must continue some support as long as he feels any weakness in the wrist. There is often some tendency to dropping of the wrist to the ulnar side, which is best counteracted by a properly constructed gutta-percha splint. The thumb is apt to be drawn in towards the index finger; this must be prevented by a thick pad of lint kept from the earliest time between the two.

Fig. 318.



Lister's splint with cork support for hand.

Fig. 319.



Hand after excision of wrist, laid on splint.

The essential points are, first, exact attention to all the details of the operation, and next, a careful and patiently conducted after-treatment.

Hand.—In the removal of diseased or injured portions of the hand, it is, as a general rule, of the greatest consequence to sacrifice as little as possible of the healthy or uninjured structures. In all operations on the hand, indeed, we must have two great principles in view—the preservation of the utility of the member, and the maintenance, so far as practicable, of its symmetry. Utility is necessarily the primary consideration; but if a part be not useful, it may, as in the case of the head of the middle metacarpal bone in amputation of the corresponding finger, be sacrificed for the purpose of preserving the symmetry of the maimed limb. The hand is the organ of *prehension* and of *touch*; and in all operations applied to it we should endeavor, as far as practicable, to maintain its efficiency in both these respects. It is also of importance to bear in mind that two great classes of actions can be carried out by the hand—those that require force, and those that require delicacy of manipulation rather than strength. By a surgical operation we may sometimes succeed in preserving one, though we are compelled to sacrifice the other; and in

the patient. Thus, by partial excision, we may leave a hand that would enable a clerk to hold his pen, but which would be almost useless to a laborer or blacksmith.

In looking at the hand from a surgical point of view, we may consider it as being composed of two constituents—the hand proper, and the *thumb;* the thumb being an accessory hand, an opponent to the rest of the member, through the medium of which the movements of ab- and adduction are chiefly performed, and without which the member is susceptible of a comparatively limited utility, being capable of little beyond flexion and extension. Hence the thumb is of equal importance to the rest of the hand: and the preservation of its three bones is as much to be considered as that of the remaining sixteen that enter into the conformation of the metacarpus and fingers. In all cases of injury or disease implicating the thumb, every effort ought to be made for its preservation. Even if it be left stiffened and incapable of flexion, it will be a most useful opponent to the rest of the hand. Should it be found necessary to shorten it, care must be taken that as little curtailment as possible be practised; a portion of a phalanx, or its metacarpal bone even, is of essential utility in giving strength and breadth of grasp to the hand. In cases of disease, a very useful member may be left by the removal of a portion or the whole of the ungual phalanx, of the metacarpo-phalangeal articulation, or even by the excision of the metacarpal bone, the phalanges being left. These various operations are easy of performance; an incision through the diseased and disorganized soft parts will expose the necrosed bone or carious joint, which must be removed by cutting-pliers or a narrow saw.

When the thumb has been forced back or badly lacerated by powder-flask or gun-barrel explosions, it may often be saved by being replaced and maintained in position on a splint, with light water-dressing over it; and, should amputation be required, it must be done in accordance with the rule just mentioned, of saving as much as possible of the injured part.

In the conservative surgery of the *fingers*, the preservation of flexion and extension in the part left is the main thing to be aimed at; a rigid stump is always in the way. The preservation of these movements becomes more important in proportion as the palm is approached. It is of more consequence that the proximal phalanx, which carries the rest with it, should be capable of being bent into the palm, than that the distal can be flexed on the second. If the proximal phalanx can be bent down, a very small degree of movement in the distal one will be sufficient to furnish pliability enough in the finger to make it a useful member; but if the proximal one be stiffened, no amount of mobility in the distal phalanx can make it useful.

In preserving these movements, it is necessary to be particularly careful of the sheaths of the tendons. If they be in any way opened or injured, it will generally be found either that the tendon sloughs, or that it becomes consolidated, and matted to its sheath in such a way that all movement is lost, or at least greatly impaired.

The only phalanx that can be excised with advantage is the distal one. It often happens, in the destructive disorganization which results from whitlow, that this necroses; when, instead of amputating the end of the finger, it may be removed by an incision on its palmar aspect. Disease of the phalangeal articulations usually leads to amputation of the affected finger. The rules for performing these various operations have already been laid down at pp. 64 and 65, to which I must refer the reader.

Resection of the *metacarpal bone*, either of the thumb or index-finger, without the removal of the corresponding digit, is occasionally required, more particularly in cases of injury; it may readily be done by making a longitudinal incision over the dorsal aspect of the bone to be removed, carefully detaching it from surrounding parts by keeping the edge of the knife close against the bone, avoiding the tendons, and then either disarticulating, or (what is preferable) cutting across the neck of the carpal end of the bone, turning it out, and separating it from any distal attachments which it may retain. After the removal of the metacarpal bone of the index-finger in this way, but very little deformity results, and a very useful hand will be left, more particularly in children, on whom I have more than once had occasion to practise this partial resection with success.

Conservative Surgery of the Lower Extremity.—In all conservative operations that are practised on the lower extremity, it is of essential importance that a good basis of support, of sufficient length and stability, be left to the body.

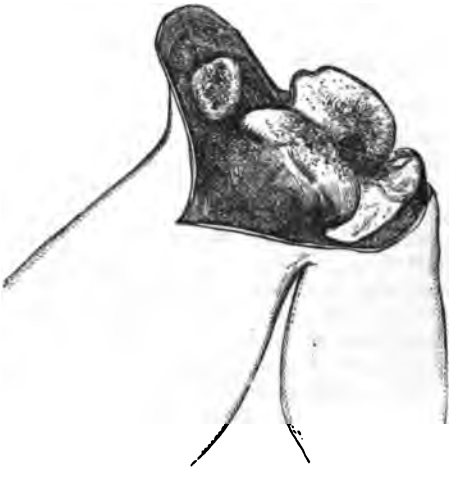
These operations differ thus in some important respects from those that are practised on the upper extremity. In the latter, the preservation of the hand, even though in a mutilated condition, is the thing that the surgeon aims at; and, provided this be attained, it matters comparatively little how much the arm may be shortened or impaired in power. In the lower extremity, however, strength, length, and solidity are essential to the patient's comfort; and unless these can be secured, his interests are better considered by the removal of the limb, and the adaptation of some artificial contrivance, than by his being left with a shortened, wasted, and crippled member, which is unequal to support the weight of the body.

Hip-joint.—Excision of the head of the thigh-bone has of late years been a good deal practised in some cases of hip-joint disease. This operation may, however, most conveniently be considered in connection with that affection (p. 776).

Knee.—Excision of the knee-joint may be required either as a subtitute for amputation in cases of extensive disease and disorganization of the articulation, or may be practised in some rare cases of faulty anchylosis resulting from old disease or injury, by which the limb has been rendered useless. This operation, originally performed at the close of last century by Park, Filkin, and the Moreaus, fell into disfavor until it was revived in 1850 by Fergusson, since which time it has been extensively practised.

Operation.—Excision of the knee-joint may be performed by making a horseshoe incision with the convexity downwards, from the side of one condyle of the femur across the tuberosity of the tibia to a corresponding point on the opposite condyle (Fig. 320). By this incision the ligamentum patellæ is divided, and that bone turned up in the elliptical flap; the crucial ligaments, if not already disorganized, are then cut across, any remaining lateral attachments divided, and the bones cleared for the saw. In doing this the limb must be forcibly flexed, and the knife carefully applied to the posterior part of the head of the tibia; for this purpose a blunt-pointed resection-knife is the best. The articular surfaces must now be sawn off. This may best be done by Butcher's saw. The lower end of the thigh-bone should first be removed, and then a slice taken off the tibia by cutting from behind forwards, the blade of the saw being turned horizontally; care should be taken not to remove more bone than is absolutely necessary, lest the limb be too much shortened. It not unfrequently happens that carious cavities are found, extending below the level of the section that has been made (Fig. 321): when this is the case, it is better to apply the gouge to them than to saw the bone below their level. It is usually sufficient to remove from one-third to three-fourths of an inch of the tibia, and about one inch or an inch and a half of the thigh-bone (Figs. 322 and 323). Should, however, the operation be required for disease of the limb, consequent upon the deformity resulting from badly reduced fractures or dislocations about the knee, as has been done successfully by Humphry of Cambridge, it may be necessary, in order to bring the limb into good position, to remove a wedge-shaped piece from one of the bones.

Fig. 320.



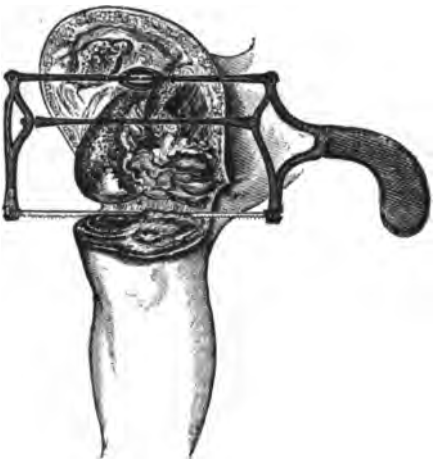
Incision in excision of the knee-joint.

If the patella be much diseased, it must be removed; if it be only slightly carious, it may be scraped or gouged out; and if healthy, in accordance with that principle of conservative surgery by which no sound part is removed, it should be left, becoming consolidated with and strengthening the joint. The anterior articular surface of the thigh-bone, which extends some way up its forepart, may advantageously be sliced off, so as to leave an osseous surface, instead of a cartilaginous one, for the patella to attach itself to.

In some cases no ligatures will be required, but usually two or three of the articular arteries furnish sufficient hemorrhage to require restraint. The patella flap

when laid down will often appear inconveniently long and thick; but it is better not to curtail it, unless the bones have been shortened more than usual, as it will contract and eventually fit it well.

Fig. 321.



Application of Butcher's saw to head of tibia.

Fig. 322.

Lower end of femur, excised.

Fig. 323.

Upper end of tibia, excised.

I have always found the operation, as it has just been described, easy of performance and good in its results; but various modifications are adopted by different surgeons. Thus, some make one straight transverse incision; others two parallel incisions, one on each side of the patella, or an H-shaped incision, and thus open the articulation from the side. Jones of Jersey, who had great experience in this operation, advised that the skin be dissected up by means of a semilunar incision, and then that the ligamentum patellæ be preserved by being pushed with the patella and the quadriceps extensor tendon to one side, the joint then opened, and the bones sawn. Others advise that the patella be removed; and Holt has recommended that, after the excision, the soft parts of the ham be perforated to allow the discharges to drain through.

The result of the operation will mainly depend on the care taken in the after-treatment. After the operation, the limb should be at once put up securely in a Liston's splint, and well supported. Subsequently, when granulations spring up, it may most conveniently be placed in a long leather trough, extending from *beyond* the foot to the pelvis, and well padded; particular attention being paid to the position of the limb, and especially to the prevention of any bowing outwards which is apt to take place. In order to prevent displacement, it has been proposed to divide the hamstring tendons; this, however, I have never found necessary, nor does it seem to me to be advisable to complicate the operation by such an addition to it. The protuberance of the flap, if at all excessive, may be diminished by the pressure of a many-tailed bandage. In this way osseous anchylosis will ensue, and a good and useful straight limb result. In two cases I have succeeded in getting a good limb with a partially movable joint: both these cases were in children; and I am disposed to think that in young patients this result may often be satisfactorily attained. In adults, however, osseous anchylosis should always be aimed at.

Results.—In determining the propriety of performing this operation, there are two points to be considered: 1. The danger attending it; and 2. The unity of the limb left after the operation.

1. In estimating the *danger* of excision of the knee-joint, we must compare the results of this operation with those of amputation of the thigh, as a substitute for which it is performed. No surgeon would think of excising a knee-joint that could be saved by ordinary medical treatment, but would only have recourse to the removal of the diseased articulation in those cases in which its condition did not admit of cure, and would consequently necessitate operation. It is, therefore,

useless to institute a comparison between the results of excision of the knee-joint and those of treatment for curable affections of that articulation; but we must compare them with those of amputation of the thigh for incurable disorganization of the joint.

In 1857, according to Butcher, excision of the knee-joint had been performed 82 times since its revival in 1850. Of these cases 15 proved fatal, and in 8 amputation of the thigh was required, of which 1 case had a fatal issue. In some instances there is reason to believe that the unsuccessful result was owing to want of due attention to the after-treatment of the case. Price has collected the particulars of 160 cases of excision of the knee performed up to December, 1858: of these, 32 were fatal—8 from pyæmia; and to these must be added 60 cases collected by Clarke, of Bristol, of which 6 died—1 from pyæmia; in all 220 cases with 38 deaths.

The mortality after amputation of the thigh has been given at pp. 60 and 80. On comparing this with the result of excision of the knee-joint, it will be found that there is no very material difference in the rate of mortality after the two operations.

[In estimating the mortality after excision of the knee-joint, it is not fair to compare it with amputation of the thigh, taking all thigh amputations *en masse*. Amputation for *disease* of the articulation, and done at or immediately above the joint, is the true object of comparison. Sixty-two cases of knee-joint amputation, for disease, gave fourteen deaths, a mortality of 22.58 per cent. (Brinton, *Am. Journ. Med. Sciences*, April, 1868, p. 555), while 208 cases of excision performed since the revival of the operation in 1850, gave a mortality of 60, or 28.84 per cent. (Hodges, *Excision of Joints*, p. 150.) It is thus seen that the mortality is more than six per cent. less for amputation than for excision. The difference is still greater for amputation through or immediately above the condyles, this operation having been done in 16 cases by Carden, without a single death (Brinton, *loc. cit.*, p. 328), while the mortality of thigh amputation for chronic joint disease is, according to Bryant, but 15 per cent. (*Med. Chir. Trans.*, vol. xlii. p. 88.) While, however, the results of amputation are more favorable as to life than those of excision, the advantages of the latter operation, *when successful*, are so manifest, that it should be the surgeon's first thought in every suitable case.—A.]

2. The second point that has to be determined, is as to the *utility of the limb* after the operation.

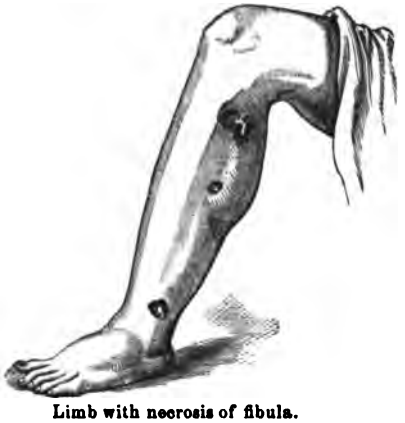
On this point, the result of recorded cases is in favor of the operation. In one of Park's cases, operated in 1783, that surgeon states that the patient (a sailor), seven years after the operation, "was able to go aloft with considerable agility, and to perform all the duties of a seaman." In some of the later cases the result has been equally good. One of Jones's patients (a boy) "could run and walk quickly without any aid of a stick, could stand on the limb alone, and pirouetted and hopped two or three yards without putting the sound limb to the ground." In several of my own cases an excellent strong and straight limb has been left, useful for all ordinary purposes. In a case which I examined seven years after the operation, the limb was well nourished, straight, firmly anchylosed, and but very little shortened. The patient, a lad of twenty, could walk eight or ten miles, and even jump and stand on the operated limb without the least pain, sign of weakness, or difficulty. In very young children the result of the operation is not satisfactory, the leg continuing shortened and wasted, not developing with the rest of the body. This is apparently due to and dependent upon the removal of the epiphysis of the tibia, on the integrity of which the growth of the limb is dependent.

After the operation, osseous anchylosis takes place with a firm cicatrix; the limb is shortened from one to three inches, according to the amount of bone removed, but by means of a high-heeled shoe this inconvenience is greatly remedied. It has been urged against excision of the knee-joint, that convalescence is tedious and prolonged; but this argument can with justice have but little weight. If a useful limb can be preserved to the patient, it can matter but little if a few additional weeks be devoted to the procedure by which it is obtained; and, indeed, it is a question whether in many cases the patient may not be able to walk just as soon after the excision of the knee-joint as after amputation of the thigh: for, as has been very properly remarked, though the amputation-wound may be healed in three or four weeks, it may be as many months before an artificial limb can be worn.

Bones of the Leg.—The *tibia* is very frequently the seat of caries in the upper and lower epiphyses, and of necrosis in the shaft, requiring partial operation for the removal of the diseased portions. Occasionally a very considerable extent of the shaft, indeed the whole of it, may be removed in a state of necrosis, as a loosened sequestrum, from the interior of the periosteum, more or less consolidated and strengthened by the deposit of new bone. Such operations present nothing special, and the result is usually very satisfactory, the limb that is left being strong, useful, and sound.

The *fibula* is less frequently the seat of operation, but it, like the tibia, may require partial removal. In one case, that of a child six years of age, I successfully removed the whole of the necrosed fibula. This operation is readily done by slitting up the sinuses in a direction so as to expose the sequestrum, which may be then drawn out without difficulty (Figs. 324 and 325). After the operation an inner

Fig. 324.



Limb with necrosis of fibula.

Fig. 325.

Limb after removal of fibula.

splint must be applied, in order to obviate the tendency to varus which will ensue. In the case from which the annexed drawings are taken, very considerable reparative action was set up in the periosteum and soft tissues along the line of bone that had been removed, new osseous matter apparently being deposited; and the child, when examined two years after the operation, had an excellent, well-nourished, and useful limb. The foot, however, had a tendency to be drawn inwards, apparently owing to the flexors having overcome the antagonism of the peroneal extensors. This deviation inwards was counteracted by the patient wearing a properly constructed boot, with which walking was perfectly easy.

Foot.—In looking at the division of the foot into its three great component parts—toes, metatarsus, and tarsus—we shall perceive that firmness of gait is given by the foot resting on the heel behind, and on the ball in front formed by the projection of the broad line of the metatarso-phalangeal articulations, more particularly that of the great toe; whilst elasticity is communicated to the tread by the play of the toes and metatarsal bones. The elasticity of the foot may be lost without any very serious inconvenience to the patient; but the preservation of stability and firmness of gait are of essential importance; and as these are secured by the heel, the ball of the great toe, and the breadth of the anterior part of the foot, these are the most important parts to preserve in all resections of this part of the body.

In no region of the body have the good effects of modern conservative surgery been more distinctly shown than in the tarsus. In the "good old times" of surgery, if a person had a "white swelling" of the bones of the foot, or a diseased tarsus, he was at once condemned to amputation of the limb. No distinction was made between diseases of the different parts of the foot, nor any attempt to save the sound by the sacrifice of the diseased part.

Until a comparatively recent period, indeed, "diseased tarsus" was described as a whole. Surgeons did not endeavor to make out the exact extent and amount of

the disease, and any case described as "diseased tarsus" was looked upon as requiring amputation of the leg. The rule of practice then observed was, amongst the wealthier classes—those who could afford the expense of a "cork leg"—to amputate a little above the ankle; but, amongst the poorer classes, to remove the leg about a couple of inches below the knee, so as to give the patient a stump which, when bent, would fit into the socket of a wooden pin. Thus, in the latter case especially, not only was the leg, itself perfectly sound, sacrificed, but the patient was exposed to great additional danger; for if there be one point more than another which has been indisputably proved by surgical statistics, it is, that the mortality after amputation increases, *cæteris paribus*, in exact proportion as we approach the trunk—every additional inch which we remove augmenting the danger to the patient. This practice continued to prevail until Chopart drew some distinctions between the treatment to be pursued, according as the disease affected the anterior or the posterior tarsal bones and articulations. He showed that, when the anterior articulations only were affected, amputation at the junction of the astragalus and calcaneum with the scaphoid and cuboid—an operation which goes by the name of "Chopart's amputation"—ought to be performed; thus removing the whole of the disease, and allowing the patient to recover with a shortened foot, with the heel preserved —one on which he could bear the weight of his body, and which would be highly useful to him.

The next step in the conservative surgery of the lower extremity, in cases of diseased foot, was the operation introduced by Syme—that of disarticulation at the ankle-joint. This was certainly a great advance; for, the flap being taken from the heel, the patient has a stump on which he can bear. The operation is also a very safe one. According to O. Weber, 17 deaths only have occurred in 101 cases of this operation. I have performed it nine times without a death, and this, in the lower extremity, is extremely satisfactory.

Since the introduction of anæsthetic agents, conservative surgery has taken great strides; and I think conservatism in surgery may be regarded as the necessary result of anæsthesia. For, although operations of this kind were performed years ago by Park, the Moreaus, and others, and their utility demonstrated, yet the operations of gouging, scraping, and partial resection were so horribly painful to the patient, and occupied so much time in their performance, that surgeons dreaded to undertake them. Of late years surgeons have learned to discriminate disease of one part of the tarsus from that of another, and to apply appropriate treatment to each.

Fig. 326.

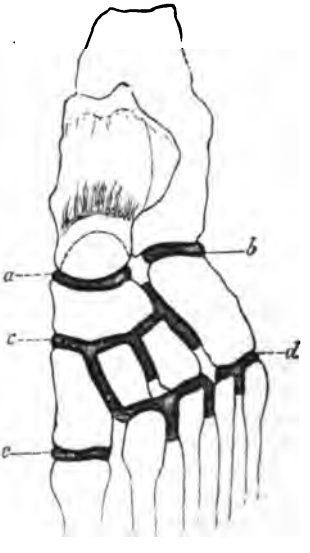


Diagram of synovial membranes of the foot.

Looking at the subject in a diagnostic point of view —and the treatment is most intimately connected with minute and accurate diagnosis—we find that the pathology of diseases of the tarsus is closely connected with its healthy anatomy. Composed, as it is, of seven bones, it presents four distinct articulations. By the term "articulation," applied to the tarsus, I do not mean merely the connection of contiguous bones with each other, but distinct synovial sacs shut off from communication with other synovial sacs in the foot. These are well represented in the annexed diagram (Fig. 326). The *posterior calcaneo-astragaloid* is the first of them; next comes the (*a*) *anterior calcaneo-astragaloid*, the synovial membrane here serving also for the *astragalo-scaphoid;* the *calcaneo-cuboid* (*b*) is the third; and the *anterior tarsal synovial membrane* (*c*) is the fourth and largest of all, and the most important in a surgical aspect. It extends between the scaphoid and the three cuneiform and the cuboid bones, between the cuneiform bones themselves, between the two outer cuneiforms and the bases of the second and third metatarsal bones, and also between the external cuneiform and the cuboid. The articulation between the cuboid and last two metatarsal bones is shown at *d*; and *e* is that between the internal cuneiform and the first metatarsal bones. These two (*d* and *e*) are not, strictly speaking, tarsal joints.

In the vast majority of cases, so far as my experience goes, it is the osseous structures, and not the articulations, which are primarily diseased. The bones, being cancellous, far removed from the centre of circulation, and exposed to alternations of temperature, readily become the seat of congestion and caries, rarely, however, of necrosis; and in strumous subjects not unfrequently fall into a tuberculous condition. Caries, whether simple or tuberculous, once set up in bones, speedily implicates the articulation secondarily.

Now it is easily understood, on casting an eye on the arrangement of the tarsal synovial membranes, that the extent of disease will, in a great measure, depend upon its seat. Thus, a person may have disease in the os calcis, extending even to the cuboid, with very little likelihood of its proceeding further for a length of time. Such disease will be limited to the outer part of the foot, does not involve its integrity, and readily admits of removal by operation. But let him have disease springing up in the scaphoid, or in one of the cuneiform bones, or in the bases of the second or third metatarsal bones, and the morbid action will rapidly spread through the whole of the anterior and inner part of the tarsus, and, in all probability, no operation of resection can be advantageously employed. Hence the seat of disease influences materially its amount and extent, and the kind of operation required for its removal.

The foot is frequently the seat of strumous disease; to this it is disposed by the alternations of temperature to which it is subjected, by its liability to sprains and injuries, and by the cancellous and spongy structure of its bones, together with its extensive articulating surfaces. When affected by strumous inflammation it becomes painful, the patient being unable to bear upon the toes or anterior ball of the foot. Swelling of a uniform character takes place, with tenderness at some point opposite the bones or articulations that are chiefly involved; and eventually abscess forms, leaving sinuses through which the probe passes down upon softened and carious bone. These evidences of disease are usually much marked about the dorsum and sides, the sole being often comparatively free from disease—an important point in reference to operation.

Strumous disease may commence either in the bones, or in the articulations of the foot. The bones that are most frequently the seat of primary disease are the calcaneum, the astragalus, the scaphoid, the cuboid, and the metatarsal bone of the great toe. When disease is limited to one or two of these bones, excision is usually practicable; but when the morbid action extends, through the influence of the connecting articulations, to other bones of the tarsus or metatarsus, partial amputation will be required.

Primary disease of the articulations of the foot is a less frequent cause of operation than caries of the tarsal bones leading secondarily to an implication of the contiguous articulations; and the particular operation required will, in a great measure, depend upon the extent of implication of the synovial membranes of the foot. When the calcaneo-astragaloid or the calcaneo-cuboid articulations are alone affected, with their contiguous bones, resection of the bones and joints implicated will often be attended by very satisfactory results; but when the large anterior tarsal synovial membrane is in a state of chronic disease, either as the result of primary morbid action set up in it, or secondarily to diseases of the scaphoid, the cuneiform, or of either of the metatarsal bones connected with it, then resection is scarcely admissible, and Chopart's amputation offers the best means of relief. The inflammation of the large and complicated anterior tarsal synovial membrane commonly commences in disease of the scaphoid. It may, usually, readily enough be recognized in its earlier stages by the pain and swelling that take place across the line of articulation between the scaphoid and cuneiform bones, the pain being greatly increased by bending the foot down, and extending across the whole breadth of the foot. For, although it is usually most severe at the inner side, which is the first affected, yet the external section of this complicated articulation, that between the external cuneiform and the cuboid, becoming involved, causes suffering to be experienced on the outer side of the foot as well. In the more advanced stages of this particular disease, the foot assumes a remarkable bulbous or clubbed appearance; the symmetry of the heel and the outline of the ankle are unimpaired, but the forepart and dorsum of the foot are greatly swollen, glazed, and possibly perforated by sinuses discharging thin unhealthy pus. I look upon this disease of the anterior tarsal synovial membrane as a distinct affection of the foot, requiring to

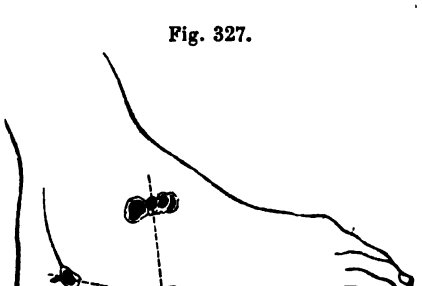
be diagnosed from the other strumous inflammations, and in its advanced stages requiring Chopart's amputation.

Tarsal Bones.—Any one of the tarsal bones may be the seat of primary disease, which morbid action may be limited to the bone originally implicated, or may extend to neighboring articulations, or through the whole tarsus. There are, however, four bones which may be looked upon as the most frequent centres of tarsal disease—viz., the os calcis, the astragalus, the scaphoid, and cuboid; and they are commonly affected in the order given. Their diseases we shall now proceed to consider.

The *os calcis*, from its exposed situation, large size, and spongy structure, is more frequently the seat of caries and necrosis than any of the other tarsal bones. Very commonly the morbid action is limited to this bone; in other instances it extends into the calcaneo-astragaloid or calcaneo-cuboid articulations.

When the disease is situated in the *posterior* or *lateral parts of the bone*, the neighboring articulations are seldom involved, and then the removal of the morbid structures by gouging will usually succeed in effecting a cure. I have frequently had occasion in this way to scoop out great portions, sometimes the whole of the interior of the calcaneum, with the most excellent results. Even when the cuboid is extensively implicated as well, and the calcaneo-cuboid articulation is the seat of diseased action, the disorganized structures may often be removed by gouging and partial resection, as in the case of which the cut (Fig. 327) is a good representation, where, by means of a ⊥-shaped incision, these bones were exposed, and their carious portions gouged out. Should, however, the caries have affected the *superior* or *anterior portions of the bone*, then the implication of the astragaloid or cuboid articulations may render the excision of the whole bone necessary, as the only means of preventing extension of secondary morbid action to the tarsus generally. So infrequent, however, is disease of the articular aspects of this bone, that its complete removal is very seldom necessary. Out of eighteen or twenty cases of caries of the os calcis that have been under my care, I have never had occasion to excise the bone but once; and Fergusson states that he has never yet found it necessary to do this operation. Indeed, excision of the os calcis should not be lightly undertaken. The large size of the bone, its importance as a basis of support to the body, and as the point of attachment to the strong muscles of the calf, should induce the surgeon, whenever practicable, to avoid its complete extirpation, and to limit himself to the application of the gouge, even though he may have to scoop out the whole of the interior of the bone, leaving little more than an osseous shell. This will fill up by the deposit of a dense fibroid tissue, which probably, eventually undergoing partial ossification, leaves the foot as useful as ever for all purposes of support and progression.

Fig. 327.



Disease of os calcis and cuboid, and of calcaneo-cuboid joint: lines of excision.

Greenhow, of Newcastle, appears to have been the first surgeon who successfully excised the whole of the os calcis. This case occurred in 1848; and since then the operation has been performed in a considerable number of instances in this country and in America, and established as one of the many important developments made by conservative surgery of late years. In France, however, it seems to have found little favor, if indeed, it has been performed. Guérin, one of the most recent French writers on operative surgery, states that excision of the os calcis should not be attempted, and gives as his only reason for describing the operative procedure, that English surgeons have not feared to undertake it.

The operation is a very successful one, and leaves a flat but useful foot. Occasionally, however, after the removal of the bone, disease is set up in the neighboring parts requiring amputation; this I have seen more than once happen; and of ten cases collected by T. M. Greenhow, it became requisite in two eventually to remove the foot.

Operation.—Excision of the os calcis is usually performed by turning a heel-flap back, as in disarticulations at the ankle-joint, and then carrying incisions forward into the sole of the foot, by which another flap is turned up, and the calcaneo-cuboid articulation exposed and opened (Fig. 35); after which the knife is carried between

the astragalus and calcaneum, and the latter bone detached. By this operation the sole of the foot is somewhat extensively incised, and cicatrices are left over the heel.

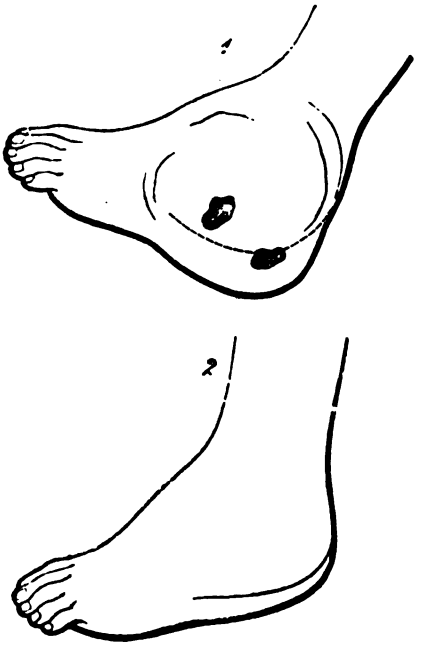
In order to avoid this inconvenience, I have found that disarticulation of the os calcis may readily be performed in the following way. The patient lying on his face, a horseshoe incision is carried from a little in front of the calcaneo-cuboid articulation round the heel, along the sides of the foot, to a corresponding point on the opposite side. The elliptic flap thus formed is dissected up, the knife being carried close to the bone, and the whole under surface of the os calcis thus exposed. A perpendicular incision, about two inches in length, is then made behind the heel, through the tendo Achillis, in the mid-line and into the horizontal one. The tendon is then detached from its insertion and the two lateral flaps are dissected up, the knife being kept close to the bones, from which the soft parts are well cleared (Fig. 328). The blade is then carried over the upper and posterior part of the os calcis, the articulation is opened, the interosseus ligaments are divided, and then, by a few touches with the point, the bone is detached from its connections with the cuboid. This bone, together with the astragalus, must then be examined; and if any disease be met with, the gouge should be applied. Should anchylosis have taken place between the os calcis and the astragalus, as I have found in one case, the bones may readily be divided by means of Butcher's saw. By this operation all injury to the sole is avoided; and the open angle of the wound being the most dependent, a ready outlet is afforded for the discharges.

The following drawing (Fig. 329) gives an excellent representation of the state of

Fig. 328.

Excision of the os calcis.

Fig. 329.



Disease of the os calcis. 1. Foot before operation; 2. Foot after excision.

the foot of a girl before and after the excision of a diseased os calcis—a somewhat flattened but most useful foot resulting.

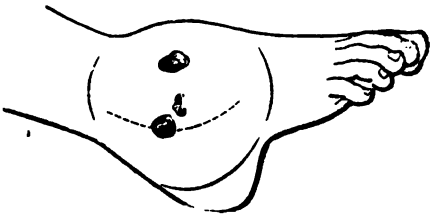
The *astragalus* is situated in a position of great surgical importance. Articulating with the malleolar arch above, with the calcaneum below, and with the scaphoid in front—forming, as it were, the keystone of the foot—it is perfectly evident that any morbid action commencing in it is very likely to spread to and involve all the more important structures of the foot. Seldom, indeed, does disease originating in

this bone long remain confined to it; and, so far as my experience goes, gouging operations, even if performed at an early period, are rarely of much benefit, the morbid action continuing to extend notwithstanding their employment. Indeed, in diseased astragalus, I believe that excision ought, as a rule, to be practised in preference to gouging, contrary to what is the case in the calcaneum.

Disease primarily originating in the astragalus may spread in three directions: upwards into the ankle-joint, downwards to the calcaneum, and forwards to the scaphoid, and thence through the large anterior synovial membrane to the rest of the tarsal bones. The treatment will vary according to the direction and extent of the disease. It may be arranged under four heads.

1. When the *astragalus alone is diseased*, we find what is seen in the drawing (Fig. 330), which represents the foot of a boy whose astragalus I excised—swelling just in front of the malleolar arch, with fistulous openings leading down to the diseased astragalus; the anterior part of the foot and the heel being quite sound. If the morbid action be limited to the outer side of the bone, or to its head, it is possible that, by freely opening up the sinuses and applying the gouge, the caries may be entirely removed. But this operation is not so satisfactory here as elsewhere in the foot, as it is by no means easy to avoid opening the astragalo-scaphoid articulation; and if this be done, disease will almost inevitably extend through the tarsal articulations. Excision of the astragalus alone, though sometimes required for disease, is perhaps more frequently called for in those cases of compound dislocation in which the bone, having been thrown out of its bed, eventually becomes carious or necroses. The operation may be done by making an incision across the outer and anterior aspect of the ankle, exposing the bone, cutting across its neck with pliers, and then with strong forceps forcibly elevating it from its bed and detaching it by the cautious application of the knife, more particularly to the inner side, where the plantar arteries are in danger. If the bone have been dislocated, and its ligamentous connections thus torn through, or if these have been disorganized and softened by disease, it may readily enough be removed as just described. But if the osseous tissue itself be carious and softened, and the ligamentous connections tolerably sound, then the operation becomes extremely troublesome, tedious, and prolonged—the bone breaking down, and having to be removed piecemeal by means of the gouge and pliers. The result of this operation is very satisfactory; a good and movable articulation may be left between the malleoli and calcaneum, and the limb is but little shortened.

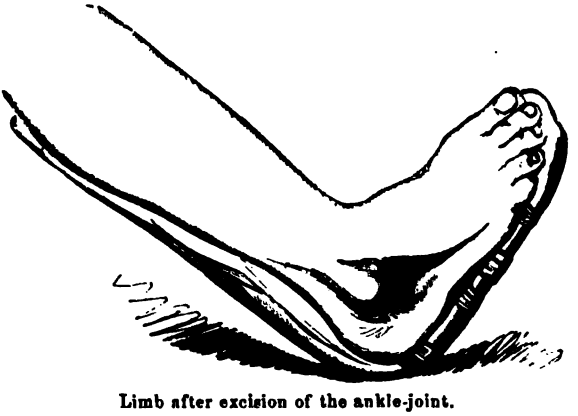
Fig. 330.



Disease of astragalus.

2. When the disease has *extended from the astragalus to the malleolar arch, excision of the ankle-joint* will be required. This operation may most conveniently be performed in the following way. A semilunar incision, about four inches in length, should be made along the outer and anterior aspect of the joint, round the lower border of the external malleolus (Fig. 330), and should be carried sufficiently forwards to give space without dividing the extensor tendons or the dorsal artery. A perpendicular cut should then be made along the fibula. The peroneal tendons having been divided, the lower end of the fibula should be cut across and detached. The astragalus, which will now be exposed, should then be separated from its connections, which, if they be much diseased, may usually

Fig. 331.

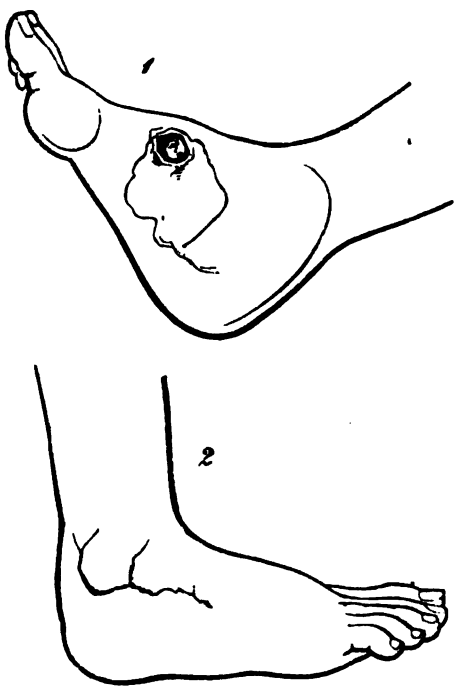


Limb after excision of the ankle-joint.

be cut across with pliers, and each fragment lifted out of its bed with gouge or pliers. The foot should now be well drawn to the inner side, and the lower end of the tibia carefully isolated; the knife being used with great caution, and kept close to the bone, lest the posterior tibial artery be injured. When the ligamentous structures attached to the bone have been separated, the inner malleolus may be cut off with bone-forceps, and as much as necessary of the lower end of the tibia removed by a gouge or a chain-saw. Should there be any disease in the articular surfaces of the calcaneum or scaphoid, this must be gouged away. The part should then be lightly dressed, and the limb placed on a Liston's splint.

3. When the disease has *extended from the astragalus upwards into the malleolar arch, and downwards into the calcaneum*, the line of practice will depend on the extent of the implication of the os calcis. If the greater part or the whole of this be involved, no resource is left but amputation—resection not leaving a useful foot. If, however, the calcaneum be only partly involved, its upper surface only being affected, a great deal may be done by conservative surgery. The treatment in such cases consists, generally, in removing the astragalus from its bed, and gouging away any diseased bone which may exist either on the upper surface of the calcaneum or on the under surface of the malleolar arch. Very large portions of bone may be removed from this situation. I have taken away the whole of the malleolar arch and astragalus, and gouged out the upper surface of the os calcis very freely; and yet the patient has recovered with a strong and movable foot, but very little shortened or deformed.

Fig. 332.



Excision of astragalus. (1) Foot before operation. (2) Foot six months after the removal of the malleolar arch, both malleoli, the astragalus, and a portion of the upper surface of the calcaneum.

The preceding cuts (Fig. 332) are taken from a young man on whom I performed the operation just described. The foot is perfectly useful and strong, and the false joint at the ankle movable. There are cases, however, in which we find that the disease has extended so far beyond its primary seat, that amputation rather than resection is required. But in the majority of instances removal of the astragalus and gouging away the upper surface of the calcaneum will suffice.

4. If the disease have *extended from the astragalus to the scaphoid*, and thence *into the anterior range of tarsal joints*, the foot will have become so extensively disorganized, that partial resection will be of little or no service; and disarticulation at the ankle-joint should be practised.

Excision of the *cuboid bone*, either in whole or in part, may be required. Partial excision is here done with the gouge. When the whole of the bone is taken away, the fifth metatarsal bone with the little toe will probably also require removal. This may be done by making the flap, as depicted in Fig. 35, only commencing the incision about an inch further back, opposite the calcaneo-cuboid articulation, and opening this instead of the metatarso-cuboid.

The *scaphoid* is very commonly the seat of primary disease; and, as this bone is connected in front with the large tarsal synovial membrane, and posteriorly with that which is common to the calcaneo-astragaloid and astragalo-scaphoid articulations, the greater part of the tarsus is apt to become speedily involved in the morbid action. It stands, indeed, next to the astragalus in its power of implicating a great extent of the foot when diseased. The extent of this implication is such that excision of the primarily diseased bone would probably seldom be attended by much

benefit, and Chopart's amputation or disarticulation at the ankle-joint becomes necessary. Next to disease of the astragalus, I look upon strumous inflammation and caries of the scaphoid as most destructive to the integrity of the foot.

When the *cuneiform bones* are the seat of caries, it will generally be found that the middle cuneiform is the bone primarily affected. Thence the disease extends to the lateral ones, or to the bases of the second and third metatarsal bones (Fig. 333). In such cases the anterior tarsal synovial membrane usually becomes extensively implicated, and Chopart's amputation will be required. But if the morbid action continue to be limited to the middle cuneiform and the contiguous metatarsal bones, and the patient's general health be good, removal of the diseased osseous structures by the gouge, with extraction of the carious cuneiform, may be attended by successful results.

Fig. 333.

Disease of cuneiform bones.

In chronic disease of the ankle and of the tarsal bones, it will occasionally happen that an excellent and useful limb may be left, after excision of a less formal kind than the operations just described. In a lad who was some time since under my care with very extensive and chronic disease of these parts, I removed the lower three inches of the fibula, and gouged away considerable portions of the end of the tibia and of the astragalus, calcaneum, and cuboid—removing a whole handful of carious bone; yet a perfect cure resulted, the patient recovering with a strong and useful foot. In infants and very young children, disease of the tarsal articulations and even bones may often be recovered from, without the necessity of having recourse to operation, by attention to the child's general health, and by giving the part rest.

It may be stated generally that the result of disease of the tarsus will be mainly dependent upon whether it is acute or chronic, progressive or stationary, diffused or limited. When it is *acute*, its limit cannot be defined, and after the removal of one portion the morbid action may be lighted up afresh in the structures, osseous or articular, that have been left. When *progressive*, there will be found to be a general tendency to disease in, or disorganization of, the tarsal structures, and partial operation can be productive of little good. When it is *diffused*, extending into the large anterior tarsal or tarso-metatarsal articulations, partial operation can avail nothing. It is in those cases in which the disease is *chronic*, *limited*, and *stationary*, or nearly so, that excision and partial operation can be beneficial.

The *malleoli* alone seldom require resection. Should either of them do so, the operation may readily enough be accomplished, in the outer malleolus, by dividing the bone with cutting-pliers; but in the inner malleolus, more care is required in avoiding the flexor tendons, the artery, and nerve, and the bone had better be cut across with a chain-saw. The removal of the outer malleolus, or rather of the lower end of the fibula, is apt to be followed by the inconvenience of a tendency to twist of the foot outwards—in fact, to a kind of valgus.

The *metatarsal bones with their toes* occasionally require removal. This is more particularly the case with the first and the fifth (page 70). The middle metatarsal bones cannot advantageously be taken away, leaving merely the first and last; but the two, three, or even the whole four of the external metatarsal bones may be advantageously resected in early life, and a useful foot left. Aston Key has recorded a case in which, in consequence of injury, he amputated the four outer metatarsal bones, the cuboid, and the external and middle cuneiform, leaving merely the line of bones supporting the great toe. The first metatarsal bone was left, supported only by the slender articular surface of the internal cuneiform; but it soon got firmer attachments, and a very good foot resulted, by which the patient retained in a great measure his elasticity of tread.

The *phalanges and articulations of the toes* seldom require resection; as a general rule, their amputation is preferable. The only case with which I am acquainted where resection of a phalanx is required, is when an exostosis has formed under the nail of the toe, pushing it up: here the removal of that portion of bone from which it springs is the best course to pursue.

The *great toe* not unfrequently requires removal, in whole or in part; but, as it enters largely into the formation of the arch of the foot, no more of it should be taken away than is absolutely necessary. It is especially of importance that the ball of the great toe, if possible, be preserved; and occasionally this may be effected by excision of the metatarso-phalangeal articulation rather than by the amputation of the member. With regard to the removal of the toe and its metatarsal bone, I must refer to page 70. Whenever it is practicable, the proximal end of the bone should be saved, in order that the insertion of the tendon of the peroneus longus may be preserved.

Amputation in Joint-Diseases.—In those cases in which excision of the diseased joint is not advisable, in consequence of the acute character of the articular disease, the existence not only of considerable suppuration but of great local and constitutional irritation, or the peculiar nature of the joint affected, amputation may be the sole resource left to the surgeon. It is especially in articular disease of the fingers and toes, of the tarsus, carpus, ankle, and knee, that this operation is required; and though it is much less frequently practised now than formerly, yet the cases of destructive disease of joints requiring amputation are amongst the most frequent in operative surgery, and will doubtless continue to be so. The surgeon, however, must be careful, whilst he avoids continuing to make ineffectual attempts to save the limb at the great hazard of the patient's life, not to amputate until it is clear that all other means have failed; the patient continuing to lose ground so, that a further perseverance in local and constitutional treatment would probably end in his death, excision not being practicable. So far from amputation being an opprobrium to surgery in such cases as these, I look upon it as one of the greatest triumphs of our art, that by a simple and easy operation, which removes the spoiled and useless limb, the life of the patient may be saved, and his health speedily restored.

In amputating in cases of chronic joint disease, where the limb has been the seat of prolonged suppuration, it will be found, just as in cases of many secondary amputations after injuries, that the condition of the muscles of the limb is peculiar. Instead of, as in cases of primary amputation, being dark in color and retracting forcibly and unequally when cut across, they will be found to be pale, soft, flabby, and retracting but little, if it all; resembling in this respect the muscles in a dead body, with the intermuscular areolar tissue often infiltrated. In consequence of this alteration in their structure and physiological properties, the flaps need not be cut so long in amputation for chronic suppurative joint-disease as in cases of primary amputation.

Circumstances influencing mortality.—The mortality after amputation for joint-diseases is specially influenced by three conditions: viz., the seat of the operation, the acute or chronic character of the disease, and the constitutional condition of the patient.

The influence of the *seat of operation* has already been discussed at p. 59.

The *duration of the disease* exercises a most important influence, especially in the larger joints—more particularly the knee. As a general rule, it may be stated that, the more acute the suppurative destruction of a joint, the less successful is the amputation of the limb likely to be; pyæmia and low secondary inflammation being especially apt to supervene.

In very acute cases, the surgeon ought to evacuate the pus by means of free incisions, and endeavor to delay the necessity of amputation until the active suppurative stage has passed, and the affection has subsided into a chronic form. In chronic cases, the success of amputation is very great. It commonly happens that a patient who has been racked with pain, and been wasting in body for weeks before the local source of irritation was removed, sleeps soundly the night after the operation, and rapidly gains flesh and strength.

In determining upon the advisability of resecting a diseased joint or of amputating the limb, the surgeon must be guided not only by the amount of disease in the articulation, but by the *constitutional condition* of the patient. In amputation the chief dangers are immediate—from shock, or secondary hemorrhage. In excision the shock is not so severe, in consequence of the incision being farther from the trunk, and through comparatively superficial and unimportant parts; no large bloodvessels, nerves, or even muscles are divided, and there is no danger of secondary hemorrhage. But in excision the dangers are chiefly remote; the suppurative

process is long continued, and the discharge of pus abundant; the patient may consequently not have sufficient constitutional power to carry him through. So far as erysipelas and pyæmia are concerned, the danger is probably the same in both operations. In addition to this, it must be borne in mind that a patient will often consent to have a joint or bone excised who would not agree to part with a limb.

As phthisis not unfrequently coexists with the advanced forms of strumous joints, the question of amputation under these circumstances becomes one of very considerable importance. If the phthisis be rapidly progressing, and there be a strong hereditary tendency to the disease, or if it have advanced to softening of the lung and the formation of vomica, it will be useless to operate. If, however, the phthisis be very slight and incipient, and be apparently due to the local irritation of and discharge from the diseased joint, to the confinement to bed that this necessitates, and to the general deprivation of health that ensues, amputation may not only be safely but advantageously practised; and I have performed it in many such cases to the manifest advantage of the patient.

CHAPTER L.

DISEASES OF THE SPINE.

SPINA BIFIDA.

It occasionally happens that, from congenital malformation, the spinous processes of some of the vertebræ are deficient, and their laminæ either absent or separated; in consequence of which, the meninges of the spinal cord are unprotected, and project through the aperture in the bones, giving rise to a tumor at the part where the arrest of development in the osseous structures occurs.

Characters.—The tumor is usually oval, its long axis corresponding with that of the spine. It generally varies in size, from that of a walnut to an orange; but occasionally it attains an immense bulk, equal to that of a child's head. In some cases the tumor is lobulated, having an imperfect septum stretching across it; in other instances, two or more of these tumors have been met with in the spine. The skin covering it is usually of its normal color; but when the tumor is of considerable size, it may be thin and have a bluish or congested appearance, and present a certain degree of transparency. In these circumstances, ulceration from distension and thinning of the skin may eventually take place. On examining the tumor, which is hard, though elastic when the child is held upright, it will be found that it becomes soft when the child is laid horizontally. It usually becomes tense during expiration, and softer during inspiration. In some cases fluctuation is perceptible, and by pressure the bulk may be lessened.

Spina bifida may be met with in any part of the vertebral column; it is, however, almost invariably found in the lumbar region, the cases in which it appears higher up being of rare occurrence; instances of the kind are, however, mentioned by Cruveilhier. When it occurs higher up, in the cervical or upper dorsal region, it has been found that the spinal cord and nerves are usually adherent to the walls of the tumor; in the lumbar region this is not the case.

The fluid contained in the tumor is of a clear limpid character. It contains chloride of sodium; and, as in the cerebro-spinal fluid, a trace of sugar is generally present.

Prognosis.—The prognosis of spina bifida will depend upon the size of the tumor and on the condition of the skin covering it. If it be of small size, with healthy integumental investment, and without a tendency to increase, the patient may live to an adult age, provided care be taken to protect the tumor. If of large size, it is generally fatal, the child usually dying at an early age of convulsions. In other instances the tumor increases in size, the skin covering it becomes thin and red, ulcerates, and gives way, and death results from spinal meningitis.

Treatment.—In the treatment of spina bifida, the line of practice must be determined by the size of the tumor and by the condition of the skin covering it. When the tumor is very large, and the skin covering it inflamed or ulcerated, or when a large portion of the bones appears to be deficient, no operative treatment is likely to be of any avail. In cases, however, in which the child is otherwise healthy and strong, the tumor being small, with healthy skin covering it, and in which little pain or inconvenience arises from pressure on it, means may be adopted for relieving or possibly even curing the deformity.

In these circumstances, bearing in mind that the disease is not necessarily fatal, we shall probably consult the welfare of the child best by abstaining from all operative interference, and merely protecting the tumor with a piece of leather or a layer of cotton wool. If it be thought desirable to attempt a cure, the simplest mode is to employ pressure on the tumor, by means of a compress and bandage; or, what is better, an air-pad, similar to those used for umbilical hernia, and kept in place by an India-rubber band. In addition to pressure exercised in this way, the recommendation of Sir A. Cooper may be followed, and the tumor punctured from time to time with a small trocar; care being taken, however, to prevent the ulceration of the punctures, by covering them with collodion. In this way, by the combination of puncture and compression, cases have been cured. All other plans of treatment, by which the tumor is opened, and air allowed to enter it, are fraught with danger, and will, I believe, be inevitably followed by the death of the child, from inflammation of the meninges of the cord and convulsions. In fact, as a general rule, all operations for the removal of the tumor are to be condemned. I have never known any but a fatal issue follow its removal by the ligature, scissors, or the knife. The only successful case of extirpation with which I am acquainted is one in which Wilson removed the tumor by the gradual pressure of a clamp applied to its base, and keeping the parts in close apposition by means of this instrument, so as to prevent the entrance of air, and the occurrence of spinal meningitis. In this case the tumor was as large as an orange, and not pedicellated. If it had a narrow base, the prospect of cure by this means would be better.

CARIES OF THE VERTEBRÆ.

This disease, which consists, in its full development, of destruction of the bodies of the vertebræ, with disintegration of the intervertebral fibro-cartilage, most commonly occurs in young children, sometimes but a few months old; but it is not unfrequently met with at all ages up to thirty. It is always, I believe, a strumous affection, consisting essentially in tubercular infiltration of the bodies of the vertebræ, followed, as commonly happens in this morbid condition, by congestion, caries, or necrosis of the osseous tissue that is in contact with or is the seat of the deposit.

Changes in the Vertebræ.—The disease primarily originates in and is usually confined to the bodies of the vertebræ, leaving the spines, the arches, and the articular processes, unaffected; but in some instances even those structures become implicated. The first development of the disease consists in the deposit of tubercle in the cancellous structure of the bodies of one or more vertebræ. The tubercle so deposited excites congestion, and inflammation leads to disintegration of the surrounding osseous structure. As the disease is tuberculous in its very nature and from its commencement, it necessarily attacks the bodies of the vertebræ, which are cancellous, in preference to the other parts of these bones which are composed of compact osseous structure, and thus not liable to be the primary seat of tuberculous deposit. The bodies of the affected vertebræ become thin, eroded, and gradually hollowed out anteriorly. In this way the bodies of from three to six or eight of the vertebræ may be destroyed; the corresponding intervertebral fibro-cartilages, which derive their supply from the contiguous bones, becoming disorganized as these undergo destruction. These changes commonly occur about the middle dorsal vertebræ; if extensive they may implicate the upper or lower dorsal, or upper lumbar, and give rise to angular projection backwards of the diseased part of the spine, corresponding in extent to the amount of destruction of the vertebræ (Fig. 334). The mechanism of this excurvation, which is usually the most marked feature in this disease, is easily understood by reference to the pathology of the affection. The bodies of the vertebræ, being thinned and weakened, at last give way

the formation of pus is so abundant and so circumscribed as to admit of recognition as an abscess. I have observed abscess occur in connection with this disease in five situations—viz., over the articulation, in the gluteal and in the lumbar regions, within the pelvis, and in connection with the rectum.

The first indication of abscess is met with over the diseased articulation. The puffy swelling which is there perceptible in the earlier stages of the affection, gradually softens, until at last fluctuation is established in it. From this point it may spread outwards into the gluteal region, nearly as far as, but not enveloping the trochanter; or it may take another course, and stretch upwards, forming a considerable accumulation in the loin, upon and just above the crest of the ilium. These forms of sacro-iliac abscess are *extrapelvic;* the other varieties are *intrapelvic.* These latter are of three kinds. In one form the pus passes out of the sciatic notch, and thus gets under the gluteal muscles; in the other variety it gravitates downwards into the ischio-rectal fossa, and presents by the side of the rectum; and, in the third variety which I have observed, the abscess opens into this gut, abundant puriform discharge takes place *per anum*, and, flatus from the bowel passing into the suppurating cavity, a tympanitic abscess results.

Prognosis.—The prognosis of this disease is always most unfavorable. I am not prepared to say that it is of necessity fatal, but I have never seen a patient recover after the full development of the disease, and after suppuration had set in. I have, however, seen a case cured, in which, from the history of the symptoms, the thickening over the sacro-iliac articulations and the permanent displacement of the side of the pelvis, there was every reason to believe that this disease had existed. But in this instance no abscess had formed.

Diagnosis.—The diagnosis of sacro-iliac disease is important, and not always easy. There are five distinct affections with which it may be confounded—viz., neuralgia of the hip, sciatica, spinal disease, coxalgia, and disease of the pelvic bones.

1. *Neuralgia of the hip* in young females may readily enough be confounded with the earlier stages of sacro-iliac disease. But the widely spread and superficial nature of the pain in the neuralgic affection, the coexistence of the hysterical temperament, the sex of the patient, and the absence of all limitation of morbid action to the neighborhood of the diseased articulation, render the true nature of the affection sufficiently clear. The obliquity of the pelvis which occasionally occurs in neuralgia of the hip, and causes apparent elongation of the limb, is readily removed when the patient lies on the back; whereas, in sacro-iliac disease, position does not affect the displacement of the limb on the affected side.

2. *Sciatica.*—In this affection, the age of the patient, usually more advanced than that of the subjects of sacro-iliac disease; the seat of the pain, below the articulation, and its extent down the back of the limb; with the absence of elongation, will enable the surgeon to effect the diagnosis.

3. From *spinal disease*, the diagnosis is usually sufficiently easy; for, although the situation of abscess resulting from caries of the vertebræ may in many cases be the same as that which is occupied by the collections of pus resulting from sacro-iliac disease, yet in caries of the spine, in the vast majority of instances, excurvation of the vertebræ has become prominently marked by the time that the abscess has assumed so great a magnitude as to occupy the inferior lumbar or gluteal regions. In those rare cases in which, as in an instance that was some time ago under my care, caries of the vertebræ, with consecutive abscess, takes place without any angular curvature, it will be found that the patient complains of tenderness on the surgeon percussing the spine opposite the seat of disease; that the spinal column has lost its flexibility, moving stiffly and as a whole; that there is an absence of that elongation of the limb on the affected side, dependent on displacement of the wing of the pelvis, which is so early observable in sacro-iliac disease; and lastly, that examination of the sacro-iliac synchondrosis neither elicits pain nor reveals swelling or any of the other signs of disorganization of that articulation.

4. *Coxalgia* is the affection that is most easily confounded with sacro-iliac disease, and that from which it is of most importance to make the diagnosis. It is especially from that variety of hip-disease which commences in the acetabulum, primarily involves the pelvic bones, and only secondarily implicates the joint, that it is difficult to distinguish sacro-iliac disease; and the importance of effecting this

diagnosis is great when we reflect that these cases of hip-disease may now successfully be subjected to operative interference, whilst sacro-iliac disease does not admit of relief or removal by these means. The diagnosis between coxalgia in all its forms and the disease we are at present considering may be effected by attention to the following circumstances:—

a. The seat of pain on pressure varies. In hip-disease the patient suffers most severely when pressure is exercised deeply behind and above the trochanter, in the hollow behind that osseous prominence, or when the compression is exercised against the anterior part of the hip-joint through the pectineus muscle. In sacro-iliac disease little or no pain on pressure is experienced in these situations; but tenderness is elicited by pressure upon the sacrum and along the line of junction between the sacrum and ilium, behind and altogether away from the hip.

b. The movements that occasion pain are different in the two diseases. In hip-disease, abduction and rotation outwards, or pressure of the head of the thigh-bone into the acetabulum, aggravate, to a greater or less degree, often to an unbearable extent, the sufferings of the patient. In sacro-iliac disease the thigh may be moved in all directions, ab- or adducted, rotated, flexed, or extended, whilst the patient is lying on the back, without any increase of suffering, provided the side of the pelvis be fixed by the surgeon. Should this precaution not be taken, the movement impressed on the thigh will be communicated to the diseased articulation, and will necessarily occasion suffering.

c. The signs connected with the alteration in the length of the limb differ in the two diseases. In hip-disease there may be, and usually is in the advanced stages, considerable shortening. This never occurs in sacro-iliac disease. In the earlier stages of coxalgia there may be, as there is throughout in sacro-iliac disease, elongation of the limb. But there is an important point connected with this. The elongation in hip-disease is always appreciable by measuring from the anterior superior spine of the ilium to the inner ankle. In sacro-iliac disease, however, the measurements between these two points on the opposite sides of the body exactly correspond, the seat of the elongation being situated still higher up.

d. The alteration of the level and of the prominence of the two anterior superior spines, in sacro-iliac disease, may be confounded with that arising from the obliquity of the pelvis usually occurring in the early stages of coxalgia. But here also the diagnosis may be effected by observing that the displacement of the bone in sacro-iliac disease is permanent, and is not influenced by position. The obliquity of the pelvis in hip-disease, giving rise to apparent elongation of the limb, is dependent on a twist in the lumbar spine, which may be rectified by placing the patient on his back, and using a little manipulation. The alteration in the level of the two ilia, in sacro-iliac disease, is not modified by change of position, or by any movement that may be impressed upon the spine.

5. *Disease of the pelvic bones* may of course occur independently of any affection of the sacro-iliac articulation; and, when so occurring, it always commences at a distance from the joint—the crest of the ilium, the tuberosity of the ischium, or the acetabulum being the usual seat of the disease. When it occurs in the first of these two situations, the resulting abscess seldom attains a very large size, and is altogether above or below the synchondrosis, the outline of which can be felt clear and unobscured by swelling of any kind. When the abscesses are opened, the sinuses that result will lead directly down to the rough and carious bone, examination of which will leave no doubt as to the nature of the case. In these cases, also, no change takes place in the length of the limb, or in the position of the side of the ilium.

When the acetabulum is primarily affected, the difficulty of diagnosis may be greater, in consequence of the large size and often intrapelvic nature of the abscesses, and the coexistence of a certain amount of displacement or elongation of the limb. But here the same circumstances that enable the surgeon to effect a diagnosis in ordinary coxalgia—viz., the pain in movement influencing the hip-joint merely, and the increased length of limb, as determined on measuring from the anterior superior spines—will prevent his falling into error as to the true nature of this disease.

Treatment.—With respect to treatment I have but little to say, and that by no means of a satisfactory character. The treatment must be conducted on the same general principles that guide us in the management of cases of carious disease of

If the cure be fortunately accomplished, the patient will probably recover with a limb that, though weakened, is but little impaired in utility; for, the sacro-iliac junction being naturally a fixed joint, it matters little whether it has become anchylosed by disease. Long-continued rest in the prone position; fixing the pelvis, hip-joint, and thigh by means of a large leather cap and splint, which should embrace the whole of the limb from above the crest of the ilium to the sole of the foot; counter-irritation, in the earlier stages, before suppuration has set in (after that has occurred it is worse than useless); the administration of cod-liver oil, iron, and suitable tonics, are the means to be employed. When once abscess forms, this must be opened in a suitable and convenient spot, when large and chronic, by valvular incision; and keeping up the powers of the patient by ordinary dietetic means and medicinal tonics, are the means that must be employed, with the view of procuring anchylosis; but usually, unfortunately, with little advantage beyond the mitigation of suffering and the prolongation of life for a limited time. When once suppuration has set in, our hopes of a cure are materially lessened. I am not prepared to state that the affection is inevitably fatal when it has reached this stage, but certainly in the very great majority of instances it is so; the profuse discharge from the large abscesses connected with it inducing hectic, and exhausting the powers of life. No operative interference is admissible in sacro-iliac disease.

CHAPTER LII.

DISEASE OF THE HIP-JOINT.

Hip-Disease presents so many points of peculiar and serious importance that it is usually, and not improperly, considered as a distinct affection, apart from other joint-diseases. Like all these it may be of an acute, subacute, or chronic inflammatory character, most commonly occurring in strumous subjects; indeed, I think its connection with scrofula is generally more distinctly marked than that of most other affections of the joints. It almost invariably occurs before the age of puberty. Out of 48 consecutive cases of this disease, of which I took notes, I find that in 16 only did it take place at or after fifteen years of age, and, of these, in 6 cases only it happened above the age of twenty; thus it may be considered essentially a disease of childhood or early youth. It commonly comes on from very slight causes; over-exertion in a long walk, a sprain in jumping, a fall, or sitting in the wet, are usually the circumstances to which its occurrence is attributed.

Forms of the Disease.—All the inflammatory affections attacking the coxo-femoral articulation are usually confounded under the term "hip-disease" or "coxalgia." This is too general an expression; and we shall find included under it several distinct forms of disease that differ from one another in pathology, symptoms, result, and treatment. On looking at the hip-joint in a surgical point of view, we find it to be composed of three distinct parts, viz., the soft structures, the acetabulum, and the head of the thigh-bone. Any one of these may be principally or primarily affected; and we may accordingly divide hip-joint disease into three distinct forms of arthritic, acetabular, and femoral.

This division is not a purely pathological one, but is of a practical character, especially in its bearing on the question of excision.

General Pathological Conditions.—Before proceeding to describe each separate form of coxalgia in detail, we may consider briefly the six pathological conditions which are more or less common to each variety of the affection—viz., pain, attitude, suppuration, sinuses, dislocation, and anchylosis.

1. *Pain.*—The pain in the hip-joint disease varies greatly according to the form the affection assumes. In the more chronic forms of the disease it is at first slight, and, perhaps, rather referable to the knee than to the hip; this is particularly the case in the *femoral* variety; and may be explained by the irritation of the articular branch of the obturator nerve. In the *arthritic* form it is always very acute, even intense,

patient's condition be greatly improved. It is a question whether an attempt at reduction should be made in these cases of consecutive dislocation, as it is very rarely that it would prove permanently successful, the acetabulum being either filled up with fibrous matter, or the head of the bone so diseased and lessened in size, that it would not remain in its cavity when put back. Occasionally, however, reduction may be successfully effected. In a woman under my care at the hospital, with spontaneous dislocation of the hip of about a month's duration, reduction was effected by means of the pulleys, and the head of the bone replaced in the cotyloid cavity, where it remained for some weeks; becoming, however, displaced again in consequence of its being necessary to remove a bandage that was applied, as she became affected with inflammation of the chest, and could not bear its pressure. If anchylosis be likely to occur, the surgeon must endeavor to secure it with the limb in a straight position. After a stiff joint has formed, the mobility of the lumbar vertebræ, and more particularly of the lumbo-sacral articulation, will be found to be greatly increased; so that at last the patient will walk with little inconvenience, rotating the pelvis on them. If the anchylosis be not osseous, but the result of the *arthritic* form of the disease, and especially if the head of the bone be still in the acetabulum, the limb may be straightened by forcible extension and rotation under chloroform, and the heel thus brought to the ground.

Excision of the Head of the Thigh-bone and of the Hip-joint.—White of Manchester, in 1769, was the first to propose, and Anthony White, of the Westminster Hospital, in 1821, was the first to perform this operation. This he did on a boy about eight years of age, who had suffered from disease of the hip-joint for three or four years, and in whom the carious head of the thigh-bone rested on the dorsum ilii. White removed the head and trochanters of the bone, and the patient recovered from the operation, dying of phthisis five years afterwards. The preparation is in the Museum of the College of Surgeons. This operation was repeated by Hewson of Dublin in 1823; and then seems to have been forgotten in Great Britain until its revival, in 1845, by Fergusson. But in the meanwhile it had not entirely escaped the attention of continental surgeons. Oppenheim, in 1829, and Seutin, in 1832, excised the head of the femur for gunshot injury; and in 1842, Textor published an essay on the subject. Since the operation was revived by Fergusson in 1845, it has been frequently performed, and may now be looked upon, notwithstanding the violence with which it has been assailed, as being an established surgical procedure in appropriate cases.

Cases requiring Operation.—Diseases of and about the hip-joint may, so far as the question of operation is concerned, be divided into two great classes—those in which no suppuration takes place, however acute the inflammation may have been; and those in which abscess forms.

To the first class belongs the *arthritic* variety of the disease. In this form of coxalgia, the patient commonly recovers with a stiffened or even completely anchylosed, though useful and straight limb, dislocation of the head of the bone not having occurred. In such cases, I believe that excision is never needed; at least, I have never had occasion to do it, nor have I ever seen a case that seemed to me to justify such a procedure.

The second class of cases—those in which abscess forms—are by far the most numerous. In the great majority of these, however, the head of the bone is the part chiefly affected, and in these recovery will take place eventually, under properly conducted medico-surgical treatment. But the recovery in such cases is always so far incomplete that the limb is left much crippled, and often of but little utility. In cases of this kind, after years of suffering and of confinement to bed, and after a hard struggle for existence, we find the unfortunate patient left eventually with a limb that is shortened to the extent of from two to four inches, wasted and adducted, with a projecting deformed hip seamed with cicatrices; the remains of the upper epiphysis of the thigh-bone being dislocated from the acetabulum, and adherent to the dorsum ilii by firm anchylosis. The limb is unable to support the body, and cannot be extended, nor can the sole of the foot be firmly planted on the ground; but the leg is to a certain extent useful in progression, the patient using it as a kind of paddle to push himself on with, as he limps on the point of the toes. In these cases, it is interesting to observe how nature compensates for the loss of all abduction and rotatory power in the hip by giving an extremely increased degree of

the disease appears to partake of the nature of a diffused ganglion.

Treatment.—The treatment, when the disease is acute, consists in leeching and blistering, with rest of the part; when it has assumed a chronic character, the application of blisters and the mercury and ammoniacum plaster will be found most useful.

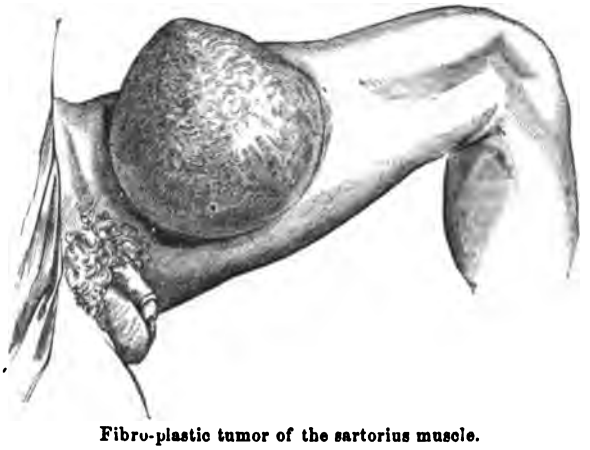
DISEASES OF MUSCLES.

The voluntary muscles are not often the seat of primary disease of any kind. *Inflammatory affections* of muscles of a rheumatic character undoubtedly occur, and abscess is occasionally met with inside muscular sheaths, more particularly that of the rectus abdominis. *Syphilitic tumors*, or rather inflammatory or plastic induration of muscles, are not very unfrequently met with.

Tumors of Muscle.—Organic structural diseases of muscular tissue are rare; yet the records of surgery contain scattered through them no inconsiderable number of cases. My friend and former pupil, Mr. Teevan, has, with much industry, collected the particulars of 62 cases of tumors of muscles of all kinds. About one-third of these he finds to have been cancerous; 16 were fibrous; 8 cystic; 5 hydatid; and 5 erectile. The form of cancer that occurs primarily in muscles is, I believe, invariably the encephaloid. I have most frequently seen the muscles of the lower extremity the seat of organic disease. When the upper limbs are affected, the muscles that have, according to Teevan, been most frequently attacked are the pectoralis major, deltoid, and biceps. The muscles of the trunk and neck are seldom diseased, with the exception of the rectus abdominis, which appears to be very liable to tumors.

I have had under my care eight cases in which tumors of different kinds developed primarily in muscular tissue. The first case was that of a woman, about 48 years of age, in whom a fibro-cystic tumor, as large as a cocoa-nut, developed in connection with the tensor vaginæ femoris, forming a large mass, which I dissected out readily from over the hip. The second case was that of a lad about 18, in whom a cystic tumor, as large as a fœtal head, thick walled, and containing clear fluid, developed in the substance of the adductor brevis of the thigh, from which it was dissected out with no little difficulty, and with a fatal result. The third case was that of a man from whom the accompanying drawings are taken (Figs. 351, 352, 353), in

Fig. 351.



Fibro-plastic tumor of the sartorius muscle.

Fig. 352.

Back view of tumor showing sartorius muscle.

Fig. 353.

Front view of tumor, laid open, and showing sartorius, A.

whom a fibro-plastic tumor developed within the sheath of and in the substance of the sartorius muscle of the left thigh, in consequence of a strain. After growing slowly for about six years, it had attained the size of a child's head, when I removed it, together with seven or eight inches of the muscle from the inside of the sheath of which it had originated, and with which it was closely incorporated. The sheath of the femoral vessels, which

was exposed for a considerable extent, was unaffected by the disease. Recurrence took place in less than twelve months in the cicatrix, and when the secondary tumor had attained the size of an ostrich's egg, it was removed, the patient making a good recovery; but recurrence of the disease took place, which eventually proved fatal. The fourth case was that of a man aged about 40, in the sole of whose foot a cystic tumor, about as large as a goose's egg, was developed, springing from the flexor brevis digitorum. This was carefully dissected out; but in a few months the patient returned, with a solid, elastic, rapidly growing tumor, evidently malignant, developed in the cicatrix. The foot was amputated, and on dissection the mass proved to be encephaloid, and to have developed from the muscular structure just named.

In three cases the tumors were hydatid. In one patient, a young woman, the disease was seated in the deltoid; in the other, a medical man, about 50 years of age, the tumor was seated at the outer edge of the latissimus dorsi; and in the third, a gentleman about 60 years old, in whose biceps the disease commenced. In each of these cases, excision of the tumor was successfully practised.

In the eighth case the tumor was an enchondroma in the tibialis anticus. I have seen two other cases of enchondroma in muscles; one situated in the vastus externus of the thigh; the other in connection with the pectoral muscle.

Tumors developing primarily in the intermuscular areolar planes are of very common occurrence; but these are very different from, and must not be confounded with, true muscular tumors.

The *treatment* of these various muscular tumors must be considered on ordinary surgical principles. When of an innocent character, as cystic or hydatid, fibrous, erectile, or enchondromatous, they may be dissected out from the muscular tissue amongst which they lie, and no fear of recurrence need be entertained.

When they are malignant, amputation of the limb, if the tumor be favorably situated for such an operation, is usually the only resource: partial operations are usually worse than useless, as they lead to a speedy recurrence of the malignant action. [If, however, the patient were seen at an early stage of his disease, the tumor might (as taught by Collis and others) be removed by a less sweeping operation than amputation.—A.] Teevan has made the ingenious suggestion of applying to malignant tumors of muscle the same rule of practice that guides us in operations on bones affected by cancer; viz., to remove the whole of the organ that is the seat of disease, excising the entire muscle from its origin to its insertion, and thus eliminating from the system the whole of the morbid mass, which will be confined within its sheath—a structure that for a long time resists the outward pressure of a morbid growth. This suggestion is founded on correct pathological principles; the only objection to it is its difficulty of application in actual practice—there being few muscles so situated that they could with safety be completely extirpated.

CHAPTER LIV.

DEFORMITIES.

LATERAL CURVATURE OF THE SPINE.

This affection, on account of the frequency of its occurrence and the tediousness of its cure, has received a good deal of attention from various surgeons; and much has been written on it by those who have specially devoted themselves to its treatment; yet the whole of its pathology and management lie in a very narrow compass.

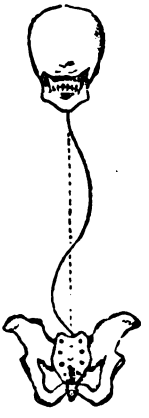
Lateral curvature of the spine most commonly commences at an early period of life, usually between the ages of twelve and eighteen—seldom before the one, and not very commonly after the other. Girls are more frequently the subjects of this deformity, which but very rarely occurs in boys. It appears to consist simply in a

vertebral column, being no longer able to support the weight of the head, neck, and shoulders, becomes curved to one side, a corresponding deviation taking place in the opposite direction at a lower portion of the spine, in order to preserve the equilibrium between the two sides of the body (Figs. 354, 355). The first curve usually takes place in the upper or middle dorsal region, the convexity tending towards the right side; the second, or compensating curve, occurs in the lumbar region, the convexity looking towards the left. In some instances there is a quadruple curve (Fig. 356).

Fig. 354.

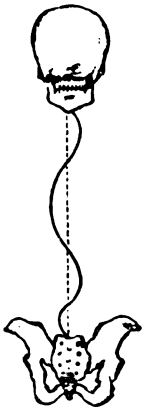
Lateral curvature and rotation of spine.

Fig. 355.



Outline of double lateral curvature.

Fig. 356.



Quadruple curve.

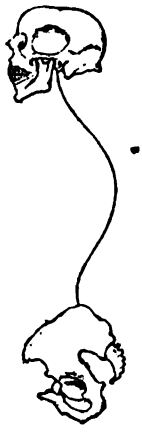
At the same time that these lateral curves take place, there is a tendency to rotation of the bones of the spine upon one another, in such a way that the bodies of the vertebræ forming the dorsal curve are twisted slightly to the left, while those which enter into the formation of the lumbar curve are turned slightly to the right (Fig. 354). This twist is sometimes slight; but in other instances it is very marked, so that there is a double curvature—lateral and rotatory.

On examining the bones and intervertebral fibro-cartilages after death, even in cases of very considerable distortion, no disease will appear in them; except, perhaps, that the bodies of some may have been slightly compressed where they form the principal concavity of the arch. The ligaments appear to be stretched, relaxed, and somewhat weakened; and the muscles are usually pale, flabby, and apparently wanting in power.

Mechanism.—From a consideration of the pathology of this affection, and from the particular age at which it manifests itself, before the bones have become completely ossified, or the ligaments have acquired their due degree of rigidity, its mechanism becomes sufficiently apparent. The spinal column, being composed of a number of separate bones, possesses no firmness in itself, or power of self-support, but is maintained in the erect position by the close manner in which its separate elements are knit together by ligamentous and muscular structures, and by the way in which, when thus bound together as a whole, it is supported on each side by the strong mass of the erector spinæ muscles. The proper tension of these ligamentous supports and muscular masses, is especially necessary for it to maintain the weight of the head and shoulders, which is thrown on the cervical and the upper portion of the dorsal spine. If, from any cause, the ligaments become relaxed, and the muscles lose their tension, or if the weight of the upper part of the body increase disproportionately to the augmentation in the strength of the ligaments and muscles that support the spine, the vertebral column will necessarily give way under the pressure to which it is subjected in a direct line from above downwards, and will consequently become curved. Most commonly, indeed almost invariably,

this takes place in a lateral direction, the spine yielding more readily in this than in any other. In some rare cases, however, the lower portion of the cervical or the upper dorsal region will project backwards in an angular manner, constituting the disease termed *cyphosis* (Fig. 357); and in other cases, of still less frequent occurrence, there may be incurvation of the spine in the dorso-lumbar region, giving rise to *lordosis* (Fig. 358).

Fig. 357.



Cyphosis.

Fig. 358.

Lordosis.

The directions in which these various curves take place are exaggerations of the natural inclination of the spinal column. In *lateral curvature*, the chief convexity takes place towards the right side, causing a projection of that shoulder which in most people is somewhat more prominent than the other. In *cyphosis*, the excurvation takes place in the lower cervical and upper dorsal regions, which are naturally prominent; and, in *lordosis*, the incurvation is most marked in the lumbar region, in which there is naturally a curve forwards.

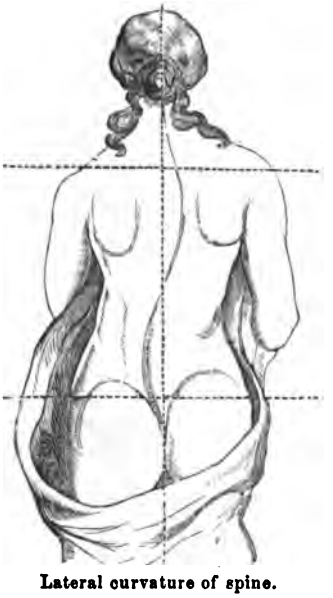
Causes.—These various kinds of deformity, as has already been stated, chiefly occur in girls about the age of puberty; at a time of life when the tonicity of the muscular system not unfrequently becomes lessened by the occurrence of anæmia and those states of impaired health that so frequently attend the establishment of the uterine function; and before the osseous and ligamentous structures of the body are fully developed. At this period of life, also, it frequently happens that the spine becomes rather suddenly elongated by a rapid increase in growth taking place; or that it becomes over-weighted by the system developing itself, and the shoulders and bust becoming stout and expanded. Indeed, so frequent is the occurrence of a certain degree of lateral curvature of the spine from these various causes, about the age of puberty in girls, that few escape a tendency to deviation; of so slight a kind, however, as not to admit of recognition as a disease. But if this tendency be allowed to go on unchecked, or if it be increased by injurious habits, amongst which are all one-sided postures in which the body is twisted, as in playing some musical instruments, or in leaning over a table in drawing and writing, the slight deviation may rapidly increase until it assume the true characters of lateral curvature of the spine. I do not think that there is any evidence to show that this is either a strumous or a rickety affection; indeed, so far as my observation goes, I should certainly say that strumous girls are less liable to the disease than those of a nervous or bilious temperament. A rickety tendency would, of course, increase the disposition to the affection; but I think this is very rarely associated with it. Amongst the more common predisposing causes must undoubtedly be reckoned the indolent and sedentary occupations, and the luxurious enervating habits that are commonly encouraged in girls in the higher ranks of life, and which, by preventing due muscular development, at the same time that they induce a general loss of tone in the system, may directly occasion the disease.

The causes of the antero-posterior curves are usually to be found in some faulty habits of the patient; either giving rise to an habitual stoop, and thus laying the foundation for cyphosis, or throwing too great a weight on the loins, and thus giving rise to lordosis. A kind of spurious lordosis is developed in some cases of anchylosis of the hip-joint.

Signs of Lateral Curvature.—The signs of this affection, when it is well marked, are distinctly obvious. The serpentine character of the curve, its double nature, the convexity on one side looking to the right shoulder, and on the other to the left loin, will render its nature evident. Most commonly it commences in a gradual manner, the first condition that frequently attracts attention being the prominence of the right scapula, which is supposed to be "growing out;" or the sterno-clavicular articulation on the same side, or some of the cartilages of the ribs, have been observed to project. Whenever the surgeon is consulted for such symptoms as these, he should at once examine the spine, which he will generally find to have an inclination to the right side. In the early stages of the disease, when the deviation is not very distinctly marked, the readiest mode of determining it is to let the patient stand upright, taking care that the feet are well placed together, and

that the attitude is not forced but natural; the surgeon should then run his finger down the back from one spinous process to another, touching each as he passes it with a pen dipped in ink; in this way, when he has reached the lower part, he will have mapped out the course of the vertebral column, and thus may see at a glance the nature and extent of its displacement. At the same time, he will probably observe that the two hips do not exactly correspond, the left being somewhat thrown out. Very commonly there is a good deal of neuralgic tenderness about the spine, and at this early stage there may be anæmia and symptoms of impaired nutrition. As the disease advances, the curvature becomes more distinct, and at the same time, owing to the torsion of the column, assumes a slightly angular character where most convex. The ribs on the right side are thrown out and bulging, and carry up the scapula with them, whilst those on the left are sunk and depressed (Fig. 359). In fact, the whole of the right side of the chest and body partakes in the projection of the spine on that side, and thus adds much to the general deformity; whilst the left side of the chest is correspondingly hollowed and sunk in. When the disease has advanced in this way, it always occasions great general debility, emaciation, and pallor: the nutrition of the body being impaired, partly by the compression to which the thoracic and abdominal organs are subjected, and partly, doubtless, by irritation set up in the spinal cord, induced by the curvature.

Fig. 359.



Lateral curvature of spine.

During the early part of the disease the spine preserves its flexibility; and whilst the curve is still recent, and the patient young, if the weight of the head and shoulders be taken off, it will at once resume its straight direction. Thus, if the patient be lifted off the ground by raising her up with the hands under the axillæ, or if she be laid down on her face on a flat couch, the back will fall into a straight position, or may readily be made to do so by slight traction. After the disease, however, has existed for some years, or if the patient have passed that age at which consolidation of the bones and ligaments takes place, the distortion will continue permanently, in whatever position she may be placed. This is not only owing to the deformity of the spine, but to the ribs, and ligamentous and muscular structures generally of the trunk, having become fixed in their abnormal position.

Treatment.—The treatment of lateral curvature of the spine should be conducted on rational principles; and, when divested of the mystery with which some interested specialists have surrounded it, it becomes as simple as that of any other chronic surgical affection of the bones, joints, or muscles. There are three principles of treatment that require to be carried out in the management of these cases. The first is the improvement of the general health—unless this be effected, nothing can be done; the second is to strengthen the muscles of the spine; and the third, to take away as much as possible the weight of the head, neck, and upper extremities.

The administration of some of the milder preparations of iron, with a course of aloëtics for the regulation of the uterine function, is of great moment; at the same time, a nourishing diet of animal food should be allowed, and the patient encouraged to take exercise in the open air. By these means the nutrition of the system will be improved, and the tone of the muscles greatly restored. The muscular power may be more directly strengthened by having the back well sponged with cold salt or vinegar and water every morning, and methodically rubbed from top to bottom. The friction should be principally directed to the erector spinæ muscles on each side of the vertebral column, and may be done either with the naked hand, or with some slightly stimulating embrocation. At the same time, if the patient's strength will permit it, but not otherwise, the use of the hand-swing may be allowed, or calisthenic exercises practised; these, however, should not be continued if they induce a feeling of fatigue or exhaustion. Whilst this plan is being persevered in,

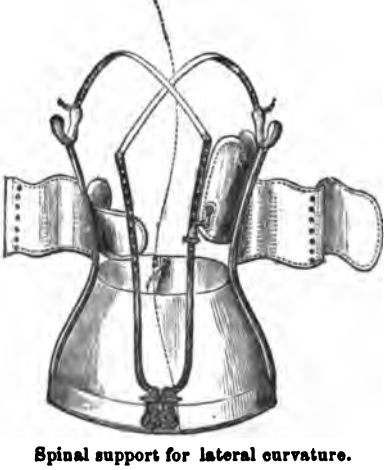
the patient should be made to lie recumbent for a few hours daily, sitting or standing as little as possible. By these means, assiduously continued for some length of time, the muscles of the back may be strengthened, and the increase of the deformity prevented; and in this way the slighter cases of lateral curvature, those in which there is rather a tendency to than a full development of the disease, may be cured.

When the affection is further advanced, though the spine still continue flexible, if there be decided projection of the ribs on one side, and the shoulder and hip be prominent, with apparent difference in the length of the limbs, and much impairment of the general health, more decided measures of treatment must be had recourse to. In these cases, as in those just described, the constitutional powers must be carefully attended to on ordinary medical principles; iron, and good living, with fresh air, being the basis of the treatment. At the same time that we endeavor to improve the strength of the system in this way, and that of the muscles of the back, especially by cold bathing and frictions, it is essential to adopt means to take off the weight of the head and shoulders, and to prevent its continuing to keep up and to increase the deformity. This may be done in two ways: by keeping the patient in the recumbent position, or by allowing her to go about wearing proper supports.

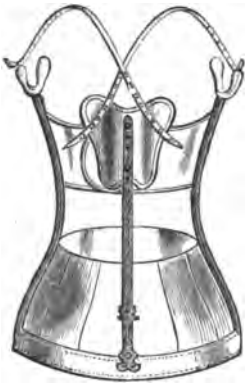
The *recumbent position* in the treatment of lateral curvature of the spine, though a valuable means as an adjunct to other measures, has been greatly abused, by being employed as an exclusive plan. This, I think, should not be, except when the patient is unable to stand or walk with comfort, as happens in some of these cases, when it may be necessary to confine her for a time to this position, until the proper muscular power has been restored by other means. These instances, however, are very rare; too much so to constitute the rule in the treatment. Whenever the recumbent position is employed, the prone seems to me far preferable to the supine, for reasons mentioned when speaking of angular curvature of the spine (p. 760); and the best couch for the purpose is certainly Verral's. The patient should be kept on this during the intervals of exercise, not being allowed to sit or stand, even at meals; she will very soon become accustomed to a position that at first appears constrained, and will, probably, speedily be enabled to sleep in it.

The *mechanical contrivances* constructed for the purpose of taking the weight of the head, neck, and upper extremities, off from the weakened spine, are of very various forms, and have had much ingenuity expended in their construction. They all have three principal objects, however much their details may vary; viz: 1, to take a broad basis of support round the pelvis, by means of a strong well-fitting band; 2, to carry off the weight of the head and upper extremities from the spine by means of lateral crutches, which transmit it to this band; and 3, to influence the convexities of the spinal curve by means of movable plates, acted upon by rack-and-pinion or screw power. The best of these mechanical contrivances for supporting the weight of the head and shoulders, is the apparatus represented in the accompanying woodcut (Fig. 360), taken from an instrument constructed by Bigg. By it the projection of the right shoulder may be gradually brought down, the left one raised, and the weight of the whole of the upper part of the body supported. By this contrivance alone, properly and carefully adjusted to the condition of the deformity, most patients may be treated without the necessity of any confinement whatever; the spine being by degrees restored to its proper direction by very gradually increasing the pressure and support of the instrument, at the same time that the general health is carefully attended to, and the patient has the benefit of good air. At first the instrument need only be worn during the day, but after a time it should be kept on at night as well. In long-standing and severe cases of lateral curvature of the spine, when its flexibility is lost, and the projection of the ribs has become permanent, a cure cannot be expected, nor can it be brought about

Fig. 360.



Spinal support for lateral curvature.



Spinal support for posterior excurvation.

by any means, but the patient will derive great comfort and support from the use of this excellent instrument, and the increase of the disease may thus be prevented.

The treatment of *posterior excurvation* of the spine, without caries or other organic disease of the vertebral column, is best conducted by the use of the instrument here figured (Fig. 361), which is constructed essentially on the same principles as that for lateral curvature, with the exception that the back-plate is so arranged as to press upon the projecting spine, and thus gradually to bring it into proper position.

Spinal support for posterior incurvation.

In *posterior incurvation* the apparatus here figured (Fig. 362) will be found the most useful appliance. In fact, all these varieties of spinal curvature may be successfully remedied by instruments constructed on the most simple mechanical principles, if carefully attended to and carried out.

CONTRACTIONS AND RETRACTIONS OF MUSCLES.

Under the head of *muscular contractions* are included various deformities, such as squint, wry-neck, club-foot, club-hand, some of which are congenital, others acquired. In all these conditions, the deformity is primarily owing to an affection of the muscular system, and not to disease of the bones or ligaments, which are only secondarily implicated.

Causes.—The causes of these deformities are very various; but they may be referred to three heads.

1. *Continuous faulty or abnormal position* of a limb, as in an unreduced dislocation or an anchylosed joint, will be followed by the disuse of a certain set of muscles, which consequently become shortened and atrophied, and acquire a rigid state. This condition is consecutive to the displacement, but renders it permanent; it is apt to occur after fractures, if the parts be kept for too long a time in one position, and more particularly if they be bound and matted together by the pressure of tight bandages. A somewhat similar cause sometimes operates on the fœtus in utero: an abnormal position in the uterine cavity being very frequently the immediate occasion of some of the varieties of congenital club-foot. These deformities must not be confounded with congenital dislocations, in which there is always an arrest of development of some of the articular ends of the bones connected with the affected joint.

2. *Irritation set up in the central portions of the nervous system*, may produce deformity by deranging the proper antagonistic action of certain groups of muscles. This condition gives rise to many of the congenital as well as of the non-congenital deformities. It may act by producing more or less complete paralysis of one set of muscles, the contractility of their antagonists continuing normal; and thus, the relative balance of action being destroyed, the stronger will draw the part over to their side. The influence of this want of proper balance of parts in paralysis, producing deformity, may be well seen in palsy of the portio dura, where the face is distorted by being drawn to the sound side; or in squint, where, the external rectus being paralyzed, the eye is drawn inwards. According to Tamplin, deformity from paralysis is never congenital, though it is not unfrequently met with in the non-congenital cases. Central irritation may occasion deformity in another way, by producing tonic or permanent spasm of one set of muscles, the other remaining perfect in their contractility, but overbalanced by the continued contraction of their antagonists. This would appear to be the case in some forms of squint. Little has made the important observation, that many cases of deformity appear to be due to mischief inflicted on the base of the brain during protracted and instrumental labors.

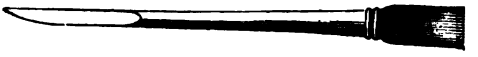
3. *Peripheral nervous irritation* may occasion contraction of the muscles and

deformity. This we commonly see happen in cases of contraction occurring fr the irritation of worms in the intestinal canal, in the so-called hysterical contracti from uterine irritation, &c. From all these various causes contraction and deform may arise. In some cases deformity will cease after the removal of the cause, b in other instances in which it has been of long duration, the deformity will contin owing to the muscles having fallen into a kind of rigid atrophy, being shorter and wasted, and consequently unfitted for the proper exercise of the actions of t part.

Treatment.—The *general treatment* of deformities consists in removing t cause of the contraction in those cases in which it is dependent on central, pe pheral, or nervous irritation that admits of remedy. Thus, if squinting arise fr pressure upon the brain, the eye will assume its straight direction when the congest vessels are relieved, or the effused fluids absorbed; or if a contraction of the ha string muscles arise from the irritation of worms in the intestinal canal, a dose purgative may cure the affection. When, however, the deformity is congenital more permanent, the employment of *mechanical means* and the *division of t tendons* is the only mode of restoring the natural condition of the part. This *orth pædic* department of surgery owes, in a great measure, its existence to the labo of Delpech and Stromeyer, and its perfection to those of Little, Tamplin, an Adams.

Tenotomy.—By tenotomy, as at present practised, is meant the subcutaneou division of a tendon by means of a very fine narrow-bladed knife (Fig. 363) intr duced obliquely through a puncture by its side. In doing this it should be borne in mind that the normal anatomical relations of parts are often a good deal disturbed in cases of deformity; and thus tendons may be approximated to arteries and nerves, from which, in the healthy condition of th limb, they are widely separated. The tendon may most conveniently be divided, i the majority of cases, by introducing the blade beneath it sideways and then turnin the edge against it, scratching through it by a kind of firm sawing movement, th handle of the knife being used as a lever to press the edge against the tendon, whils the parts are made tense by an assistant. A drop or two only of blood are lost i this simple operation; and, as the divided tendon retracts with a kind of snap, gap will be left between the two ends, from half an inch to an inch in width, accordin to the previous amount of tension in the part. If the muscles have been contracte for some years, it will commonly be found that the fasciæ in the neighborhood o the tendon have become rigid and unyielding, forming cords or bands stretchin across from the side of the gap. If these be very tense, they may be divided in th same way; but in many instances it will be found after a lapse of a short time tha they will yield, and consequently will not require division. After the section ha been made, the small puncture should be closed with a pad of lint and a strip o plaster, the admission of air into the wound being carefully guarded against. Th whole success of the operation depends on this. Should air enter, inflammatio and suppuration will to a certainty be set up; whereas, if this be avoided, th wound will heal by the effusion of plastic matter without any inflammation. It i the entry of air, and not the subcutaneous wound, that gives rise to inflammation. The part should then be left without any apparatus being applied for three or fou days. At the expiration of this time lymph will have been thrown out, and the proper mechanical contrivances may be adjusted for gradually restoring the norma position of the limb or part; if this be done too soon, the cicatrix will be extende at too early a period after the deposit of the plastic matter, and the tendon wil become weakened and too much elongated.

Fig. 363.



Tenotomy-knife.

Chloroform is not always admissible in these operations. In some cases it wil be found that under its influence the muscle becomes so much relaxed that th defined edge of the tendon disappears, and the proper section cannot be made.

The mode of *repair in divided tendons* has given rise to some controversy, there being two theories with regard to the process. According to one, the plastic matte deposited between the divided and retracted ends gradually undergoes a process of contraction, analogous to what takes place in the cicatrix of a burn, so as to cause approximation of the cut ends of the tendon at the expense of the muscle,

which becomes partially lengthened, until at last a transverse linear cicatrix merely is left at the line of section. Adams has, however, conclusively shown that this theory is erroneous, and that repair is effected by the deposit of plastic matter between the cut ends, chiefly from the sheaths and soft parts around; that this plastic matter undergoes gradual transformation into tendinous tissue; and that the tendon is actually lengthened and remains permanently so, by the deposit of this new material, which eventually resembles the normal structure of tendon so closely that the microscope fails to detect any appreciable difference in structure, and that it can only be distinguished by its more translucent appearance from the old tendon. In fact, the divided tendon is completely regenerated or reproduced.

In cases of congenital malformation, the question frequently arises as to whether tenotomy should be performed in early infancy, or delayed to a more advanced age. As a general rule, I think that, if imperative, the sooner these operations are done the better; they are not more difficult at an early period of life than at any other, no danger attends them, and when they are performed during infancy, there is a far less chance of the deformity being permanent, than if the operation be delayed for some years. But it must be remembered that many slight deformities and contractions in infants may be removed without operation, by attention to proper mechanical and hygienic means. The surgeon should, therefore, not be too ready to operate in slight cases at tender ages.

DEFORMITIES AFFECTING THE FACE AND NECK.[1]

Wry-neck.—Wry-neck, *torticollis*, or *caput obstipum*, arises from spasm of one of the sterno-mastoid muscles; the head being drawn to the affected side. On close examination in wry-neck it will be found that there is a triple displacement of the head, which is drawn downwards, rotated outwards, and inclined laterally towards the affected side. The features lose their symmetry; the half of the face, and even of the head, on the affected side, becomes less perfectly developed; the true line of the eyebrows, eyes, and mouth, becomes displaced and lowered.

In torticollis the affected sterno-cleido-mastoid will be found hard, defined, and shortened; and sometimes both divisions of the muscle are equally tense, standing out in strong relief, so as almost to look like two distinct muscles. In other cases one division, and then most usually the sternal, is chiefly affected. After a time the cervical vertebræ participate in and maintain the displacement, becoming rotated on their axes and curved. Eventually the whole spinal column participates in the displacement, and lateral curvature sets in. The deeper muscles also become shortened, and the anterior margin and clavicular attachment of the trapezius will often be found tense and preternaturally defined.

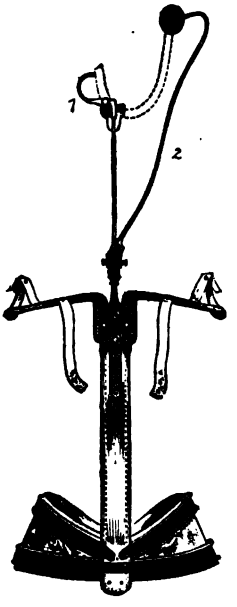
Causes.—Wry-neck occasionally appears to be congenital; more frequently it is acquired, coming on in childhood after measles or scarlatina, or as a consequence of inflamed cervical glands. It not unfrequently commences with an ordinary stiff neck from cold. In whatever way it originates, the spinal accessory nerve is probably at fault, and it is owing to the irritation of it that the sterno-mastoid and trapezius muscles take on a spasmodic action. In spasm of both sterno-mastoids the head is thrown forwards, the muscles projecting in great relief. In these cases, the disease will usually be found to have had a rheumatic origin. Deformity in this situation may also occur from diseased cervical vertebræ, or from the traction of the cicatrix of a burn. The conditions here, however, are peculiar, depending upon causes that are irrespective of the state of the muscles, and may readily be distinguished from the true form of the disease produced by the causes above mentioned.

Treatment.—The treatment of torticollis arising from permanent spasm of one of the sterno-mastoids, which is the common form of the affection, may best be conducted by dividing the inferior attachment of the muscle, and thus allowing the head to regain its proper position. The division of the muscle is a somewhat delicate operation, on account of the important structures that lie immediately behind it. By making the incision, however, through it, from behind forwards, close to the sternum and along the clavicle, there can, if ordinary care be employed, be little risk of doing any damage, as these bones carry the lower attachment of the muscle forwards, and separate it from subjacent parts. The tension also into

[1] For Squint, *vide* Chapter on "Diseases of the Eye."

which it is thrown by its spasm draws it away from the carotid sheath. In several instances in which I have had occasion to perform this operation, no difficulty whatever has been experienced in dividing the sternal attachment of the muscle, which is usually very tense and prominent, by passing an ordinary tenotome behind the tendon, with its flat side towards it, just in front of the upper margin of the sternum, and then cutting forwards, whilst the muscle is put well upon the stretch. In dividing the clavicular insertion, the safest plan, I think, consists in making a puncture with a scalpel upon and down to the clavicle in the cellular space which lies between the two attachments of the muscle, and then pushing a long blunt-pointed, narrow-bladed tenotome between that bone and the insertion of the muscle, dividing this in a direction forwards. Care must be taken to divide the muscle completely, but not to carry the incision too freely or deeply. I have heard of more than one case in which, from want of due precaution, abundant hemorrhage occurred, and of three in which fatal results followed the operation.

Fig. 364.



Bigg's apparatus for wry-neck.

After the operation, the position of the head must be gradually rectified by proper apparatus (Fig. 364). The best instrument for this purpose is the one invented by Bigg, and here figured. It consists of a pelvic band, a vertebral stem, and arm-pieces, the object of which is to secure a firm basis of support to the neck lever (1), and the maxillary lever (2). The neck lever passes round the head, and takes its bearing against the temporal bone on the side towards which the head is deflected. The maxillary lever acts against the lower jaw on the opposite side—that which is turned up. By means of a ratchet-joint the neck lever, the action of which is vertical, turns the head from the side to which it is deflected, whilst the maxillary lever, acting horizontally, rotates the head on its vertebral axis. By the combined action of these two forces the head is restored to its vertical position, and the chin replaced in the mesial line. In this way the curvature of the cervical vertebræ may gradually be corrected; should it, however, have existed for a considerable time, it may have assumed a permanent character, and a twist in the neck will continue for life. If the operation be not delayed too late in life, the features will gradually regain their symmetry. After the division of the tendon, the deep fascia of the neck will sometimes be found stretching across in firm and tense bands; these, however, had better not be interfered with, as they will yield in time, and much risk of injuring the subclavian and carotid vessels would attend any attempt at their division. The exposure and division of the spinal accessory nerve has been practised, but not, I believe, with much benefit.

In those cases in which the wry-neck appears rather to be dependent on paralysis of one sterno-mastoid, than on spasm of the other, electricity, and the application of strychnine to a blistered surface over the muscle, will be found most useful.

[The form of wry-neck which is dependent on subacute rheumatism, has been successfully treated by Dr. J. M. Da Costa, of this city, by the hypodermic injection of atropia (*Penna. Hosp. Reports*, vol. i. p. 392), as recommended by Dr. Cowdell in cases of lumbago and sciatica. (*Med. Times and Gaz.*, March 17, 1860.)—A.]

DEFORMITIES OF THE ARM AND HAND.

Contraction of the Arm is not of very common occurrence, except as the result of burns. I have, however, met with four distinct forms of contraction of the forearm.

1. There may be anchylosis of the elbow-joint, the forearm being bent at a right angle with the arm, the result of disease of or around the articulation. If the anchylosis be fibrous, and the muscles strong and firm, a very useful limb may be restored by breaking down adhesions, under chloroform, by forcible flexion and extension, and then using passive motion, friction, and douches. Should the muscles be very flaccid and wasted, forcible extension may leave a permanently weak-

ened limb, over which the patient has lost the power of flexion. In such cases I have found gradual extension, made by means of an angular splint, acted upon by a ratchet-apparatus, the safest means of restoring the utility of the arm. [Extension may be conveniently effected by means of a weight attached to the wrist, and brought over a pulley, lateral support to the elbow being afforded by side splints or a fracture box from which the foot-piece has been removed.—A.] If the anchylosis be osseous, the bones should be resected, a wedge-shaped piece being sawn out, and a false joint allowed to form.

2. The biceps may, by its contraction, occasion a permanent flexion of the arm. This contraction of the biceps may be hysterical or rheumatic. When hysterical, occurring in young women, it requires the ordinary constitutional treatment of hysteria; should this fail in removing it, extension may be made under chloroform, and the arm kept in the straight position for a time. When it is rheumatic, or of organic character, and permanent, section of the tendon and its aponeurosis may be practised, due care being taken of the artery and nerve. This operation is most safely done by introducing the tenotome to the inner side of the tendon, slipping it under, and cutting upwards and outwards; the artery being guarded and pushed to the inner side by the pressure of the left forefinger.

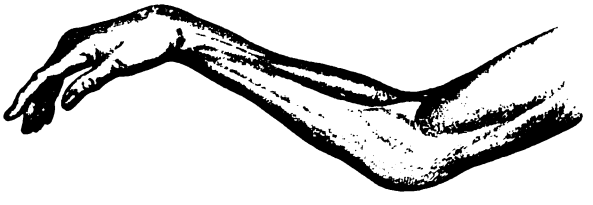
3. The forearm may be forcibly pronated and flexed as the result of chronic inflammation of the radio-humeral articulation. Here forcible supination and extension, under chloroform, is the best remedy.

4. The forearm may be bent on the arm in consequence of the contraction of the cicatrix of a burn along the inside of the limb. In this case the plastic operation described at page 166 must be practised.

Anchylosis of the Arm in the Straight Position is a condition of very serious inconvenience to the patient, the limb being almost useless for all ordinary purposes of life. In cases of this kind, the treatment to be adopted must depend upon whether the anchylosis be fibrous or osseous. If it be fibrous, however firm, the forearm may always readily be brought into a rectangular position by flexion under chloroform, and the mobility of the joint may then be improved or restored by passive motion, friction, and douches. If osseous, the bony union must be sawn across, and the case treated as an ordinary instance of excision of the elbow, with the view of establishing a false joint.

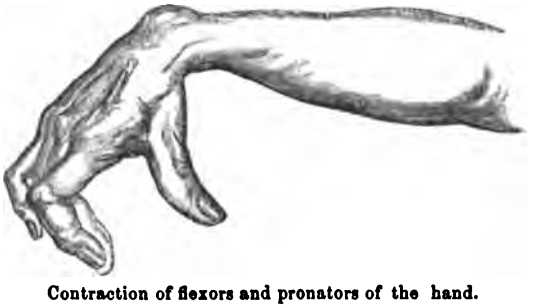
Acquired Contraction of the Muscles of the Forearm implicating the Hand is occasionally met with in adults. I have seen it in two opposite conditions; that of forcible extension (Fig. 365), and that of forcible flexion and pronation (Fig. 366). In both instances it appeared to have been the result of excessive use of certain muscles; in the first case in wringing out clothes, in the other in cutting with very heavy shears. In the case of flexion and pronation, it was interesting to observe that, when the fingers were extended, the wrist became flexed, and when the wrist was extended the fingers became bent in. In these cases change of occupation, friction, and galvanism, with the use of a straight splint, were advantageously resorted to, a cure being eventually effected.

Fig. 365.



Contraction of extensors of the hand.

Fig. 366.



Contraction of flexors and pronators of the hand.

Club-Hand.—A deformity resembling club-foot has occasionally, though very rarely, been met with in the hand. The contraction may occur in two directions; either in the sense of preternatural

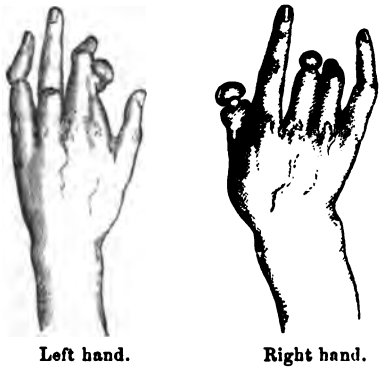
flexion, or in that of abnormal extension of the member. It has been described by Cruveilhier, Vollemier, and Smith of Dublin. In most of the cases that have been met with, there was a certain amount of deformity of the lower end of the radius, with congenital dislocation of the wrist; and in Smith's case there was an accessory semilunar bone in the carpus. Little, if anything, can be done by surgery for the relief of this deformity; though some benefit might possibly result from the division of any tendons that were preternaturally tense.

Contraction of the Fingers.—A contraction of the fingers, which are drawn into the palm of the hand, is often met with. Most commonly this commences in the little finger, and thence gradually extends to the ring and middle fingers, which become so forcibly and firmly curved inwards, that their extension is not practicable. It commonly results from frequent and continued pressure on the palm of the hand, as in leaning on a round-ended stick in walking, or in those trades in which an instrument requires to be pressed into the hollow of the hand. In many cases, however, it occurs in persons in the prime of life without any apparent exciting cause. In such cases I have always found it associated with a rheumatic or gouty diathesis; the disease in fact consisting in chronic thickening of the fasciæ of the palm and fingers, resulting from rheumatic inflammation of these parts. On examining the contracted fingers, projecting ridges will be felt extending from the palm to their anterior aspects; and on endeavoring to straighten them, these ridges will be found to become stretched, and the palmar fasciæ to be rendered tense. The skin covering these ridges is usually healthy, but sometimes adherent to them. So firmly are the fingers contracted, that by no effort can they be extended.

Pathology.—The pathology of this contraction has given rise to a good deal of difference of opinion amongst surgeons. Dupuytren appears to have been the first who endeavored, by dissection, to ascertain its true character. He found, on examining a hand which was the seat of this disease, that, after the removal of the skin, which was loose and flaccid, the contraction continued as before, and this, therefore, could not be its seat; but that the palmar fascia, which was exposed, was tense and diminished in size, whilst from the lower aspect some cord-like prolongations passed up by the side of the fingers; and that, when these were divided, the contraction was immediately removed, the tendons, the bones, and the joints being perfectly sound. He considered these fibrous cords to be digital prolongations of the palmar fascia, and consequently looked upon this membrane as the seat of the disease. Goyrand, who has carefully dissected hands affected in this way, states that these fibrous cords, which he looks upon as the seat of the affection, are not prolongations of the palmar fascia, but are ligamentous structures that extend from its anterior inferior aspect to the sheaths of the flexor tendons, into which they are inserted opposite the second phalanx; being an hypertrophied condition of the subcutaneous filaments of fibro-cellular tissue which naturally exist in this situation.

Treatment.—The treatment of this deformity, when slight and recent, consists in dividing each tense digital ligamentous prolongation by a subcutaneous incision. This should be done opposite the second phalanx, where it is usually most tense; but, if the other finger-joints be affected, a separate section may be required opposite each phalanx. Should it be found to be impossible to straighten the fingers with such limited incisions, or should the skin be firmly adherent to the subjacent fibrous band, a long crucial incision may be made through the skin, this dissected back, the bands divided or dissected off the sheaths of the tendons, and the fingers straightened. As the flexor tendons are not primarily affected, they need not be divided. After the operation, the hand should be placed on a digitated splint. More rarely the contraction of a finger is found to be due to retraction of the flexor tendon. The division of this will be followed by immediate restoration of the finger to the straight position.

Fig. 367. Fig. 368.



Left hand. Right hand.

Remarkable congenital deformity of fingers.

Remarkable Congenital Deformity of Fingers.—The accompanying figures (367, 368)

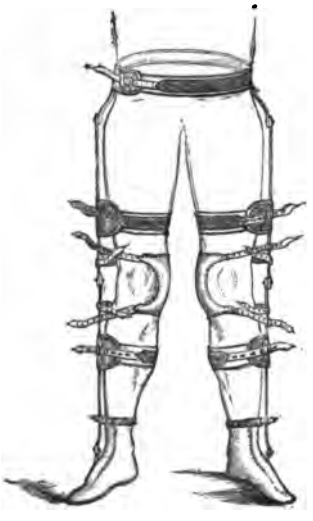
under my care. In it the fingers appear to have suffered in some instances complete, in others partial, amputation *in utero*. Some were marked by deep transverse sulci, others shortened and terminating in rounded nodules, with a narrow pedicle connecting them with the proximal phalanx.

[I have seen a similar congenital deformity affecting the leg, in a living child, and a remarkable example of the same condition affecting the thigh in a fœtus, was shown to the College of Physicians of this city, by Dr. A. Nebinger. In this case it was apparent that the partial amputation was due to the twisting of the cord around the affected limb. (*Trans. Coll. Phys.*, in *Am. Journ. Med. Sciences*, July, 1867, p. 129.)—A.]

DEFORMITIES OF THE LEG AND FOOT.

Knock-knee.—The deformity termed *genu-valgum*, *knock-* or *X-knee*, usually affects both extremities, though it is generally more fully developed in one than in the other. In it the knee forms the apex of a triangle, the base of which would be represented by a line drawn from the trochanter to the outer ankle. It is usually conjoined with some curvature of the bones of the leg. It is not a congenital affection, but commonly occurs in consequence of children being put upon their feet too early, the limbs thus giving way under the weight of the body. Brock states that, out of 221 cases which he examined, 17 originated about the period of the first dentition; and about 200 between that age and the 15th or 18th year. Some occupations are said to predispose to it, smiths being especially liable to the disease. In it there is relaxation of the internal lateral ligament; the biceps, the external lateral ligament, and often the vastus externus, are very tense; and the patella is thrown outwards. The external condyle of the femur will generally be found to be small, and the hollow of the ham to be obliterated.

Fig. 369.



Apparatus for knock-knee.

Treatment.—The treatment consists, in the slighter cases, in applying an apparatus consisting of a well-padded iron stem along the outside of the leg and thigh; this must extend from the trochanter to the outer ankle, being fixed to a pelvic band at the upper part, and into a boot below (Fig. 369). Where it corresponds to the knee it should be provided with a hinge, and should have a broad well-padded strap passing from its under side, over the inner side of the joint, and attached by buckles to the upper part of the stem, in such a way that by tightening these the knee may be drawn outwards. This apparatus should be constantly worn for many months; and, if properly adapted, may effect a cure.

When the deformity is of old standing, and the parts about the outer side of the joint very tense, the biceps tendon may require division. In doing this, care must be taken not to injure the peroneal nerve. In some cases the vastus externus and contiguous portion of the fascia lata may also be advantageously divided, and the apparatus then applied as directed.

Contraction of the Knee-joint.—Contraction of the knee-joint is one of the most distressing deformities to which the human frame is liable. If it be severe, the leg is bent at nearly, or perhaps at quite, a right angle with the thigh. It is fixed in this position, so that the patient cannot put the sole of the foot, nor even the points of the toes to the ground; hence the limb becomes useless for the purpose of progression, and, from want of exercise, atrophies. But a leg with a badly contracted knee is worse than useless—it is a positive incumbrance; for, as the foot cannot be brought fairly to the ground, the limb projects behind in a most awkward manner, swaying as the body moves round, constantly in the way, and liable to injury. From want of exercise, the nutrition of the limb thus affected becomes

impaired; the foot is usually habitually cold, the circulation in it is languid, and the toes become liable to chilblains and troublesome ulceration.

In the less severe forms of contracted knee, the inconvenience, though not so great as that just described, is yet very considerable; for, as the patient can never bring the heel or sole to the ground, he rests insecurely on the tips of his toes, and walks but unsteadily with the aid of a crutch or stick.

Varieties.—This deformity may be of two kinds. 1. It may consist of simple flexion of the leg on the thigh, at a greater or less angle, and with more or less mobility, according to the degree of anchylosis. 2. In addition to this, there may be horizontal displacement of the bones, the head of the tibia being thrown backwards, the femur and patella remaining *in situ*, but apparently projecting more than is natural.

In examining a case of contraction of the knee-joint, the patient should be placed on his face, with the thigh extended. The leg on the affected side will then be raised more or less perpendicularly, and the amount of contraction may be judged of by the angle that it forms with the thigh. The degree of mobility also may readily be ascertained. In this way a more correct idea of the amount of contraction can be obtained than by examining the patient whilst lying on the back, when, in consequence of the thigh being flexed on the abdomen, the extent of the angular deformity cannot be so well determined.

Causes.—Contraction of the knee-joint may arise from a great variety of pathological conditions. Some of these are altogether external to the joint, being seated in the nerves or muscles of the limb; whilst others, and the majority, consist in some morbid change that has taken place within the joint itself in its ligamentous or osseous structures. As the contraction depends on such very varied causes, the *treatment*, having reference to the cause as well as to the actual morbid conditions, must be equally diversified.

Contraction from nervous irritation is usually associated with general hysteria, of which it is but a local symptom, and commonly occurs in girls and young women. In this form of contraction there is no evidence of disease within the joint; no redness, swelling, or other sign of inflammation; but there is great pain and tenderness about it. This pain, as usual in hysterical cases, is superficial and cutaneous, and radiates to some distance beyond the articulation. Any attempt at straightening the limb not only greatly increases the pain, but also calls the adjoining muscles into such forcible action that it is impossible to improve the position. These local symptoms are connected with the ordinary signs of an hysterical temperament, with spinal irritation, and often with uterine derangement.

The *treatment* of these cases of *hysterical contraction* of the knee is simple. The first thing to be done is to straighten the limb. This can only be effected by putting the patient under the influence of chloroform, when, all sensibility being suspended, the muscular opposition, which is partly voluntary, and no doubt in some measure reflex, is no longer called into action, and the limb falls of its own accord almost into the straight position, in which it must be retained by means of a long splint, lest the retraction recur with returning consciousness; and then, the hysterical condition being removed by treatment calculated to improve the general health, the tendency to the return of the deformity will be obviated.

We occasionally see contraction of the knee from spasmodic action of the hamstrings, produced by some irritation applied to the nerves at a distance from the part. Just as spasm of the internal rectus muscle of the eye occasions squint, so long as the irritation that gives rise to the spasm lasts; so there may be spasm of the hamstrings, with contraction of the knee as a consequence.

Most commonly, however, the joint itself is at fault, either in consequence of subacute inflammatory action within it, or of the chronic and permanent changes induced by former inflammatory attacks.

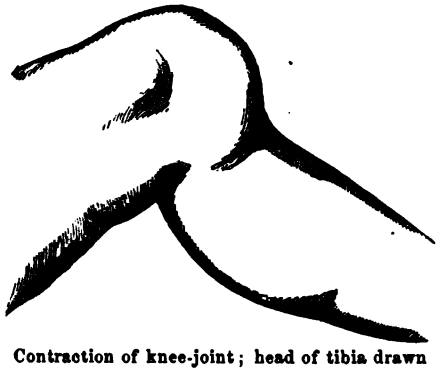
Contraction from inflammation of the knee.—In inflammation of the knee, the patient naturally and instinctively places the limb in the semiflexed position, as being that in which there is least tension exercised on the structures that enter into the joint, and consequently that which is most congenial to his feelings. This position, which is immediately assumed on the occurrence of acute and active inflammation in the joint, comes on more gradually in cases of subacute inflammation; and here the symptoms of disease in the joint may be so slight that the contraction may be considered the chief ailment, and engross too exclusively the surgeon's attention.

Chronic contraction.—The next class of cases that we have to consider are those

structural lesions of a deep and important character in and around the joint, and requiring very active surgical interference for their cure. These chronic forms of contracted knee appear to arrange themselves in three distinct varieties, being dependent—1, on consolidation and contraction of the ligamentous structures in or around the joint; 2, on permanent contraction of the muscles, with or without the last-named condition; and, 3, on osseous anchylosis. Each of these varieties will require separate consideration, as each demands a special mode of treatment for its cure.

1. Those cases of contraction of the knee that depend on *consolidation of the ligamentous structures* in and around the joint, resulting from former inflammatory attacks, are not only the most numerous, but the most readily amenable to treatment. When the structures outside the joint, such as the capsule and ligaments, are the parts chiefly affected, the inflammation has usually been of a rheumatic character. When the internal structures have been disorganized, and fibroid deposits have taken place within the joint, the inflammation has generally been strumous. In these cases the knee is usually fixed at or near a right angle, and is capable of but very limited motion; to such a degree only, in most instances, as will allow the foot to move to the extent of two or three inches. The hamstring muscles are not tense, even when the knee is extended to its utmost; and, indeed, in some cases they are flaccid, and feel soft. Not unfrequently the leg admits of extension up to a certain point, with as much freedom as in the natural state, and then the further movement of the limb is checked by a sudden stop. If this be not dependent on the tibia coming into contact with an anchylosed patella, it is owing to shortening of the crucial ligaments, or to the formation of adhesions within the joint. In this form of contraction, the knee is often much distorted, in consequence of the head of the tibia being partially dislocated backwards, the femur having its axis directed more or less to one side, most commonly inwards, constituting a kind of genu valgum. In fact, in these cases the distortion of the limb is of a threefold character; there are, 1, contraction in the angular direction backwards; 2, displacement of the head of the tibia backwards from the lower end of the femur, which projects considerably forwards; and 3, rotation of the leg and foot outwards. The angular contraction is dependent upon adhesions in the joint, and on the gradual tendency to flexion that all inflamed joints assume. The partial dislocation backwards is, I believe, dependent on softening and consequent relaxation, either of the ligamentum patellæ or of one or other of the lateral ligaments. When the head of the tibia is displaced backwards, it will most generally be found that the ligamentum patellæ has been either partially absorbed, and thus weakened; or that it is elongated, the patella being drawn upwards or to one side. In either way, the action of the extensor muscles of the thigh upon the head of the tibia is weakened; and that bone, being consequently brought under the influence of the hamstrings without a counterpoise, is drawn backwards (Fig. 370). In those cases in which there is lateral rotation of the tibia, the faulty position may either have arisen from the attitude that the limb has been allowed to assume during the progress of the disease in the joint, or the leg was rotated outwards by the action of the biceps overcoming that of the inner hamstrings.

Fig. 370.



Contraction of knee-joint; head of tibia drawn backwards.

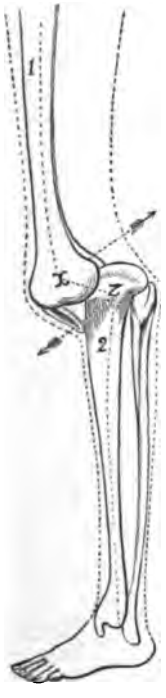
In the *treatment* of contraction of the knee, extension of the limb will prove sufficient when there is simple angular contraction. This may either be done gradually by means of the screw-splint behind the knee, or forcibly and at once under the influence of chloroform. I prefer the latter method, not only as being the speediest, but as being perfectly safe and effectual. The mode of effecting forcible extension is as follows. The patient being fully under the influence of chloroform, and lying on his face, the surgeon, standing above him, seizes the foot of the affected limb

with one hand, whilst with the other he steadies the limb just above the knee. He now extends the leg gradually but forcibly; as it comes forwards, the bands of adhesion in and around the joint will be felt and heard to give way with loud snaps and cracks, distinctly audible at some distance. Should there be much resistance within the joint, the surgeon may apply his own knee or elbow to the upper surface, and thus increase the force with which the limb is acted upon. In this way I have never found any contractions of the kind now under consideration able to resist the surgeon's efforts, nor any difficulty in effecting at once the extension of the limb. Nor have I ever seen any evil consequences result; indeed, it is surprising to what an amount of force a joint that has been contracted for any length of time may be subjected without inconvenience. In these cases it would appear as if the synovial membrane lost its susceptibility to inflame, just as is the case with serous membranes that have been the seat of chronic inflammation and its consequences. Beyond some pain for a few days, and slight heat, easily subdued by cold evaporating lotions, I have never seen any ill results arise; but then care must be taken that no inflammatory action is going on within the joint at the time of this manipulation, as, if such action were present, the operation would certainly be followed by injurious results. After the extension has been made, the limb should be fixed on a long splint, well padded, some evaporating lotions applied, and the patient kept in bed for a few days, after which, with the aid of a starched bandage, he may walk about.

[Contraction of the knee may be often satisfactorily treated by extension applied by means of a weight attached to the ankle, lateral support being given by side splints or a fracture box without foot-piece.—A.]

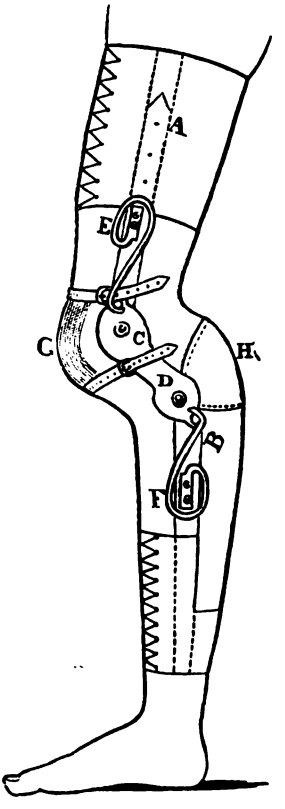
When the triple displacement which has already been referred to exists—viz., angular contraction, displacement of the head of the tibia backwards, and rotation of the limb outwards—simple extension is no longer sufficient for the remedying of the deformity. In these cases the hamstring tendons may often require division, generally on both sides—sometimes only the external one; and extension may then require to be effected, either forcibly, or by the gradual and slow action of rack-and pinion apparatus. After extension has been effected, the position of the head of the tibia backwards may still occasion considerable deformity and weakness of the limb (Fig. 371). This condition is best removed by the use of the instrument of which the sketch (Fig. 372) is a good representation; it was designed and constructed by that excellent surgical mechanician, Mr. Bigg. The diagram (Fig. 371) represents a limb with the tibia displaced backwards, the angular contraction having been remedied. In the centres of the end of the thigh-bone and of the head of the tibia, two letters (X and Z) are placed to designate the axis of each bony head, beneath and above which the displaced joint has formed its abnormal axis. The dotted lines represent the leverage formed by the cylindrical surface of the tibia and thigh-bone. The arrows are placed in such a direction as the bones would take in resuming their normal position. It will readily be seen that any instrument capable of acting in the mechanical directions shown by the arrows, would not only accomplish the restoration of the joint, but extend, if contracted, the extremities of both femur and tibia.

Fig. 371.



Knee-joint after extension: head of tibia thrown backwards.

Fig. 372.



Apparatus for restoring position after extension of contracted knee-joint.

An additional advantage that this instrument possesses over any other with which I am acquainted, is the application of spring-power, by means of which flexion of the knee becomes an element towards the restoration of its utility.

Instead of muscular action being arrested, and atrophy of the limb being thus produced, movement is conducive to the perfect action of the apparatus; so that the patient experiences but little inconvenience from its use, all the ordinary positions assumed by the knee in walking, sitting, or standing, being preserved.

By this form of apparatus, then, three important points are secured; viz., replacement of the head of the tibia, extension of the angle of the leg, and free muscular action during the period of treatment.

In Fig. 372, A and B are two levers, composed of metal, corresponding in their direction to the perpendicular position of the thigh-bone and tibia. C and D are two axes, placed exactly coincident with the centres of the articular ends of the bones. E and F are two powerful springs, acting in opposing directions, viz., in those indicated by the arrows in Fig. 371. Thus F presses the lever B in an anterior direction, bearing the end of the tibia forward, whilst E presses the lever A in a posterior direction, bearing the end of the thigh-bone backward. As C and D are found acting above and below the actual axis of the knee-joint, they mutually influence the point formed by the apposition of the heads of the tibia and thigh-bone; and as it has already been explained that the thigh-bone really offers a fixed resistance, and the tibia moves beneath it, the head of the latter bone is turned anteriorly in a semicircular direction consequent on the upper centre (C) being a fixed point, and the lower centre (D) rotating around it. G is an elastic knee-cap; H, a padded plate. When the ligaments are tense, there is a chance of pressing the anterior surface of the tibia against the posterior surface of the thigh-bone. This is readily obviated by having the shaft (A) made to elongate, when the centre (C), being a little lowered, pushes the lever (B) downwards, carrying the tibia with it, and thus separating the osseous surfaces of the joint.

2. The next class of cases of contracted knee that we have to consider are those in which the *hamstrings are contracted*, either alone or in addition to those results of chronic inflammatory action within the joint that have just been described. In these cases the hamstrings will be found to be tight; and in proportion as the leg is extended on the thigh, they will become more tense, until at last all further extension is resisted, apparently by their traction, and not by any sudden check or stop within the joint itself.

Division of the hamstring tendons is in ordinary cases as simple an operation as any in surgery, unattended by any difficulty, provided the surgeon introduce the tenotome parallel and close to the side of the tendon to be divided, and cut in a direction from the inside or popliteal aspect towards the skin. The outer hamstring will usually be found to be the most tense, and should first be divided. In doing this, the peroneal nerve might appear to be in danger; but this may be avoided by keeping the side of the tenotome well against the inner edge of the biceps tendon, then turning the edge outwards, when passed deeply enough. The semitendinosus requires division next. The semimembranosus need not often be cut across. After the division of the tendons, tense aponeurotic bands will not unfrequently be found to stretch along one or both sides, or perhaps down the centre of the popliteal space. This may lead to the idea on the part of the surgeon that he has not fairly cut the tendons across; but this is an error. The bands alluded to are condensed sharp-edged prolongations of the fascia lata, formed during the period of contraction of the joint by the retraction and thickening of this membranous expansion. Such condensations as these had better be left untouched, as they will readily stretch out under gradual extension, or be ruptured by forcible traction of the limb. If, on the other hand, the surgeon be tempted by their apparently superficial and safe position to proceed to their division, he may be led into a serious dilemma by being brought more closely into contact with the popliteal vessels than is desirable or safe. In these cases, the anatomical relations of parts are so much altered by the narrowing of the popliteal space, and by the projection of the head of the tibia backwards or by its lateral rotation, that the surgeon is unable to calculate with sufficient nicety the precise position of the large vessels and nerves in the neighborhood of which he is about to act; and he may thus injure one or other of these at a time when he thinks that he is operating at a safe distance from them.

After the division of the hamstrings, the knee does not commonly come readily

into the straight position; but gradual extension, by means of proper apparatus, will be required to break through or extend the adhesions within and around the joint.

[Forcible extension should not be employed after division of the hamstring muscles; I have seen in one instance a large and deep-seated abscess in the popliteal space, produced by violent efforts at extension.—A.]

Contraction with lateral displacement is not unfrequently met with. In these cases the knee is contracted more or less in the angular direction; but, in addition to this, the lower end of the thigh-bone is directed inwards and perhaps somewhat forwards, and the tibia is rotated outwards, carrying the foot with it. There is thus a triple deformity—angular, mesial, and rotatory. I believe the angular to be the primary deformity, and the mesial and rotatory to be secondary to this, arising partly from the efforts of the patient to walk by resting on the point of the great toe, and throwing the thigh inwards in order to effect this, and partly from the action of the biceps rotating the leg inwards.

The *treatment* of these cases is not very satisfactory. Mere extension of the limb, whether gradual or forced, may counteract the angular deformity; but it will not only leave the other displacements uninfluenced, but may actually increase the rotation of the leg outwards. A leg and thigh-splint, such as in Fig. 372, but having instead of the springs, a rack-and-pinion apparatus working on three centres, so as to extend the limb, abduct the knee, and rotate the leg inwards, is the only contrivance by which this deformity can be counteracted, and the limb properly restored to shape.

In reference to the treatment of these various deformities of the extremities, it may be stated generally that it is much easier to rectify faulty position than to restore mobility. The first may always be done by the various means that have been enumerated; the latter can only be effected, if at all, by long-continued efforts on the part of the surgeon, by passive motion, frictions, shampooing, &c., aided by properly constructed apparatus.

3. *Osseous anchylosis of the knee* is not of very frequent occurrence. It is usually, if not invariably, the result of traumatic inflammation of the joint. If the limb be straight, no operation will be advisable; if it be *bent*, so that the patient cannot put the foot to the ground, the only remedy will be an operation. Rhea Barton, of Philadelphia, in 1835, proposed an operation for restoring the straight position of the limb in cases of complete osseous anchylosis of the knee-joint with angular deformity. The operation consists in excising a wedge-shaped piece of the shaft of the femur above the condyles, not including the whole diameter of the bone, then fracturing the undivided portion, and so bringing the limb into a straight position. Buck, of New York, in 1844, modified this operation by sawing out a wedge-shaped portion, consisting of the condyles of the femur, the patella, and the head of the tibia. According to Gross these two operations have been done in all in 21 cases, of which 4 proved fatal by pyæmia. In one case, that of Riel, the femoral artery had to be tied for secondary hemorrhage from the popliteal on the fifteenth day; but the patient made an excellent recovery with an useful limb. Brainard, of Chicago, in 1854, proposed a simple and less severe method than either of the above, for the remedying of angular osseous anchylosis of the knee. It consisted in drilling the femur subcutaneously and then fracturing the bone. This operation was first done by Pancoast in 1859, and since then has been successfully practised by Brainard, Gross, and others, who have extended it to subcutaneous perforation of the joint and to separation of the patella.

Fig. 373.

Drill for femur.

The drill that is used for this operation consists of a steel shaft $4\frac{1}{2}$ inches long, fitted with a solid and rounded handle (Fig. 373). The point is $\frac{1}{6}$th of an inch in breadth, and has on each side an oblique groove with cutting edges, so that it acts as a gouge as well as a drill. The interior of the obliterated articulation is reached by making an incision about half an inch long on the outer side of the limb at the line of juncture, between the condyles of the femur and the tibia. The drill is then worked through, until its end can be felt under the integuments on the opposite side of the limb. The instrument must now be worked in such a manner as to break down the osseous adhesions between the femur and the tibia on the one hand, and the patella on the other.

The patella is sometimes best loosened by using the drill as a lever. When the bones have been sufficiently perforated in different directions, the limb must be extended, when the remaining osseous connections will give way with a cracking noise. The wound in the integument is then closed with silver sutures and collodion, and the limb laid on a pillow. In three or four days it may be put in a McIntyre splint and gradual extension practised, the soft parts posteriorly slowly yielding. Bony union will then take place: but it is a decided advantage when the limb is stiff for the knee not to be quite straight, but slightly flexed, so that the leg may be about an inch shorter than the opposite limb.

This operation, it will be seen, is in many respects superior to those of Barton and Buck; for, whilst bringing the limb into an equally good position, it does so by a comparatively slight and subcutaneous procedure, unattended by any danger of hemorrhage or of complications arising from an extensive external wound. The nine cases in which it has been done were all successful. These various perforating operations appear hitherto to have been confined to the knee-joint. But there can be little doubt that they might advantageously be extended to other joints, when affected by osseous anchylosis, more particularly in the elbow and the hip.

Anchylosis of the knee in the *straight position* interferes comparatively little with the utility of the limb. It is, however, desirable, when practicable, to restore the flexibility of the joint. The possibility of doing this will depend on the degree of anchylosis. If this be osseous, or even if densely fibrous, little can be done; but if the rigidity depend chiefly on condensation of the capsule, and the deposit of plastic matter externally to the joint, much may be effected by the use of properly constructed apparatus. This should be of two kinds: 1. A leg and thigh piece securely laced on to the limb, having an angular joint opposite the knee, and united posteriorly by a strong band of vulcanized India-rubber, the elastic tension of which is constantly striving to overcome the straightened limb by flexing it backwards; and 2, a similar apparatus, with rack-and-pinion, instead of elastic, by which the knee can be screwed back once at least in the day.

Anchylosis of the knee in the *angular position forwards*, so that the leg is bent upwards upon the thigh, is of very rare occurrence. Indeed, I am acquainted with only two preparations illustrating this deformity—one in the museum of St. Thomas's Hospital, and another exhibited by Adams to the Pathological Society, from a limb amputated by Grant, of Canada, in which this condition occurred in a young man as a consequence of a wound of the joint some years previously.

Club-foot.—Deformities of the foot may either affect one or both of the extremities. They may be congenital or acquired, and may occur in either sex, but appear to be more common amongst boys than girls. There are four primary varieties of club-foot and two secondary ones. Of the four *primary* forms, in two the deformity is in the antero-posterior direction, in the sense of flexion and of extension: *talipes equinus*, in which the heel is drawn up and the toes pointed downwards; and its antithesis, *talipes calcaneus*, in which the heel is drawn down and the toes pointed up. In the remaining two forms the deformity is lateral, the foot being adducted and twisted inwards in *talipes varus*, and abducted and twisted outwards in *talipes valgus*. Besides these four primary forms, there are two secondary varieties of club-foot: *talipes equino-varus*, in which the heel is raised and the foot drawn inwards; and *talipes calcaneo-valgus*, in which the heel is drawn down and the foot turned out. The *talipes equinus* and *varus* are commonly associated, because in these forms the flexor and adductor muscles, viz., the strong muscles of the calf and the tibialis posticus, those that are supplied by the posterior tibial nerve, are at fault. The *talipes calcaneus* and *valgus* are associated, because in these the extensor and the peroneal muscles, those supplied by the peroneal nerves, are the seat of contraction.

[In addition to the above there are two other secondary forms of club-foot recognized by systematic writers, to wit, *equino-valgus*, and *calcaneo-varus*.—A.]

Pathological Changes.—On dissecting a foot affected by talipes, it will be seen that but little alteration has taken place in the condition of the bones. In some preparations of this kind which are in the University College Museum, these are nearly in a normal condition (Figs. 374–377). Indeed, in talipes equinus and calcaneus, they are scarcely if at all altered; but in talipes varus, if of old standing, the astragalus will generally be found atrophied, more particularly about its head, which may be somewhat twisted, and the scaphoid and cuboid bones will be seen to

have undergone similar changes. The ligaments are necessarily somewhat altered in shape, being lengthened on the convexity, and shortened on the concavity of the foot; the direction of the tendons is altered, and the muscles, not only of the foot, but of the leg and thigh, are generally atrophied from disuse, so that the limb in old cases is withered and shortened; indeed, so great an incumbrance may it occasionally become under these circumstances, that amputation of the leg may be insisted on by the patient, and with propriety be performed by the surgeon.

Talipes equinus is characterized by elevation of the heel, and tension of the tendo Achillis. In slight cases the heel may merely be raised a few lines above the ground, and it will be found on examination that it cannot be bent forwards to an acute or even to a right angle with the leg. In severe cases the foot may be extended in nearly a straight line with the leg, and the patient walks on his toes, which are placed at a right angle to the foot (Figs. 374, 375). In this deformity there is no lateral displacement. According to Tamplin, it is never congenital. It most commonly arises from disturbance of the nervous system during teething, or from the irritation of worms in children. In adults, as well as in children, it may come on from some disease, such as abscess in the calf of the leg, by which the gastrocnemius muscle is crippled. It is the most important, and at the same time the simplest in itself, of all the forms of club-foot; it commonly complicates the varus.

Fig. 374.

Talipes equinus.

Fig. 375.

Bones in talipes equinus.

The *treatment* consists in *dividing the tendo Achillis*, and bringing the heel well down.

The tendo Achillis is best divided about an inch above its insertion into the os calcis. The patient should be laid prone; the surgeon, grasping the foot, extends it forcibly, so as to throw out the tendon in good relief, and make it tense; he then slides a tenotome beneath it, and cuts slowly through it from beneath upwards, bearing well upon the foot; as the division proceeds, he will hear the tendon cracking as its fibres are successively cut through. The division should not be made from above downwards, as the posterior tibial artery or its malleolar branches might readily be wounded.

Talipes calcaneus is an extremely rare variety of club-foot. In it the heel is depressed, the toes and anterior part of the foot being elevated (Fig. 376); it is usually, I believe, congenital—in one case, however, that of a girl twelve years of age, it was acquired. It arises from contraction of the extensor tendons.

Fig. 376.

Talipes calcaneus.

Treatment.—In order to bring down the foot, the tibialis anticus, the extensor communis, the extensor pollicis, and the peroneus tertius muscles, may all require to be divided as they pass over the dorsum; a straight splint should then be applied, and the foot drawn down to it. A minor degree of this affection consists in a peculiar projection upwards of one or two of the toes, associated with some tension of the extensor tendon; by dividing this, and keeping the foot on a flat splint, the deformity may commonly be corrected. In some cases, however, the toe is so prominent, and the contiguous ones are squeezed under it in such a manner, that the foot is completely crippled, and amputation of the displaced digit is required in order to restore the utility of the member.

Talipes varus.—In this deformity the foot is twisted inwards, and the sole is contracted; the patient walking on the outer side of the foot, where the skin covering the tarsal end of the fifth metatarsal bone often becomes excessively dense and firm, and a bursa occasionally forms. (Figs. 377, 378). In most cases there is some elevation of the heel, the affection partaking somewhat of the character of talipes equinus. It is the most common form of congenital deformity, both feet being found similarly affected; but it may be non-congenital, and then it is limited to one foot.

Fig. 377.

Talipes varus.

Fig. 378.

Bones in talipes varus.

The *treatment* consists in the successive division of the tendons of the tibialis anticus and tibialis posticus, which are the muscles principally at fault. After these have been cut across, the tendo Achillis should be divided; but its section should be made last, as it steadies the foot, and thus facilitates the division of the tibial tendons. In most cases the plantar fascia is contracted, and requires division wherever it feels tense and projecting. In the section of the tibialis posticus tendon behind the ankle, there is much danger of wounding the posterior tibial artery, which lies close to it. The best way to avoid this vessel is, as Tamplin recommends, to puncture the sheath of the tendon with a sharp scalpel introduced directly downwards, and then to divide it in a direction forwards, away from the vessel, with a blunt tenotome. There will also be less risk of this accident occurring, if the line of the tibia be clearly felt and taken as the guide for puncturing the fascia over the tendon. Unless great care be taken in cutting through the tendo Achillis, there is also some risk of wounding the artery; as, in bad cases of varus, these two structures lie nearly parallel to one another, the tendo Achillis being drawn out of the median line towards the inner ankle. Indeed, in one instance I have seen the posterior tibial artery punctured during the division of this tendon, or rather in an attempt to divide some tense bands that lay beneath it; the bleeding which was very free and in a full jet, was, however, readily stopped by pressure, no bad consequences resulting. The proper plan of treatment, when such an accident occurs, is, when the artery is merely punctured, to cut it completely across, and then apply firm pressure, by means of a pad and bandage, over the bleeding orifice. Tamplin states that he has seen no ill effects follow this accident. If a circumscribed false aneurism form, it must be laid open, the clots turned out, and the vessel tied. No extension of the foot should be practised for some time in such cases, lest the coagulum be disturbed.

In ordinary cases of varus, after a lapse of four or five days, Scarpa's or Little's shoe, or Aveling's talivert, may be applied; or the foot may be well abducted by means of a wooden splint, fixed to the outer side of the leg, and provided with pegs, so placed that the toes can be drawn up, and the foot well turned out, by rollers and tapes attached to them.

Fig. 379.

Talipes valgus.

Talipes valgus—flat or *splay foot*—is the antithesis to varus. In it there is a tendency in the first instance to obliteration of the arch of the instep, so that the sole becomes perfectly flattened; and, as the disease advances, a tendency to eversion of the foot usually takes place (Fig. 379). When it has advanced to this extent, the toes and anterior part are often somewhat raised, so as to constitute the variety termed *calcaneo-valgus*. In talipes valgus the ligaments of the sole of the foot, which bind the bones together so as to form the arch, are weakened and elongated, and the peroneal and extensor tendons are commonly tense. It is not so frequent a form of club

foot as the other varieties. It commonly affects only one extremity, being often met with in young adults, as the consequence of over-fatigue of the foot from long-continued standing, and from the habit of sliding the foot in walking, or twisting it, so as to press upon the inner side. When both feet are everted, there is usually knock-knee as well; and then this affection is met with at a much earlier period of life.

Treatment.—In the earlier stages of acquired talipes valgus in young adults, more particularly in young women, the deformity may often be remedied by putting the patient under the influence of chloroform, forcibly drawing the foot inwards, so as to overcome the tension of the peronei muscles, fixing it in a Dupuytren's splint, and afterwards restoring the arch of the foot by a convex sole in the shoe.

In the more confirmed cases, the treatment consists in the division of the tendons of the peroneus longus and brevis, behind the outer ankle; and of that of the extensor communis on the dorsum. Scarpa's shoe may then be applied, and the arch of the foot restored by wearing a pad under the sole for some considerable time.

In *talipes calcaneo-valgus* the projection of the heel backwards is obliterated, and the outer side of the foot curved round towards this, so that the little toe approaches the point of the heel. It is not a congenital affection; and, as it commonly arises from a partially paralyzed state of the gastrocnemius, the treatment is not very satisfactory.

Contraction of the Plantar Fascia.—In some cases, great arching of the instep and shortening of the foot will result from contraction of the plantar fascia. Here the division of the internal and middle prolongations of this structure will be necessary; after which, a Scarpa's shoe with a jointed foot-piece may be used, to effect extension of the arch of the foot.

Contraction of One Toe is not of unfrequent occurrence. In this complaint the proximal phalanx is either on its normal level or slightly drawn up; the two distal are bent down at an acute angle, the apex of which is formed by the articulation of the first with the second. This contraction more commonly affects the second toe, is often symmetrical in the two feet, and is frequently a source of great inconvenience, and even permanent lameness. It appears to be due to contraction of the digital prolongation of the plantar fascia, and is best remedied by dividing this subcutaneously opposite the lower part of the second phalanx, and then straightening the toe.

Weak Ankles not uncommonly occur in rickety children; the ligaments being relaxed, the joints appearing to be swollen, and the child being unable to walk or stand without great difficulty. In these circumstances, attention to the state of the general health, douching with salt water, with the application of an elastic India-rubber bandage round the ankle, or the use of light iron supports, will be found most useful.

DISEASES OF REGIONS.

CHAPTER LV.

DISEASES OF THE HEAD AND NECK.

DISEASES OF THE SCALP AND SKULL.

Fungus of the Dura Mater.—Sometimes without external or apparent cause, at other times in consequence of a blow or fall, a *fungous tumor* grows from some part of the dura mater, usually on the top of the head or one of the parietal regions. As it increases in size, it produces absorption of the skull covering it; the bone becomes thinned and expanded, and crackles like parchment on pressure, sometimes not being raised above its proper level, but more usually being pushed

up by the pressure of the growth beneath, which at last protrudes under the scalp. More usually, this perforation of the skull is gradual; but in some cases it would appear to have been sudden, the first intimation that the patient had of disease being the presence of a tumor under the scalp. When the skull is perforated, the sharp edges of the circular opening can be distinctly felt; and the tumor which protrudes pulsates distinctly, as may be proved both by the finger and by the eye.

Symptoms.—Symptoms of cerebral disturbance—double vision, loss of sight, deafness, or epileptic fits, with fixed pain in the head—usually precede for a considerable time the external appearance of the tumor. In some rare cases, no such symptoms have indicated the existence of intra-cranial disease; and the first evidence of the disease has been the sudden protrusion of a pulsating tumor through the skull. If the tumor be compressed, egg-shell crackling of the expanded and thinned cranial bones will be felt, and, if attempts be made to push it back under the bones, giddiness, syncope, and convulsions are produced. As the disease makes progress, death from paralysis and coma supervenes.

Treatment.—The result of the treatment of fungus of the dura mater is not very satisfactory; yet, as the disease appears to be almost of necessity fatal if left to itself, something should be attempted—not, however, until the tumor has fairly appeared through the bones. The scalp covering it should be turned back by a crucial incision, and the tumor exposed. The aperture in the skull through which it is protruded may then, if necessary, be enlarged by the use of the trephine or Hey's saw, so as to lay bare the full extent of the tumor, which must then be carefully dissected away from the dura mater.

Fungus of the Skull may occur. At first it closely resembles the disease just described; it differs from this, however, in being devoid of pulsation, and incapable of being pushed back. It appears to spring from the diploë of the skull, and may probably be of a myeloid or encephaloid character, sometimes secondary to primary deposits of a like nature elsewhere. In other cases it appears to be simply vascular, in structure resembling the pulp of a red gooseberry or a broken-down mulberry. In a case of this kind which I had an opportunity of seeing some years ago, the growth was successfully removed by B. Phillips.

Hernia Cerebri, arising from wound or ulceration of the dura mater, has been already described (p. 352).

Encephalocele, or **Congenital Hernia of the Brain,** is a rare malformation usually speedily fatal. Z. Laurence finds that, of 39 instances in which it occurred, 21 were males, 18 females; that the protrusion may vary from the size of a pea to that of a tumor exceeding the child's head; and that the occiput is its chief seat—of 79 cases, 53 being in this situation. In 6 instances, the subjects of this malformation reached an adult age; in all the remaining cases they died early, or were still-born. Surgery offers little in these cases; though in one instance the protruding portion of brain was successfully sliced off, the patient surviving.

Tapping the Head.—It occasionally happens in children afflicted with acute hydrocephalus, and sometimes, though more rarely, with the chronic form of the disease, that the distension of the head and the compression of the brain by the intra-cranial accumulation of fluid threatens immediately the life of the patient.

In these circumstances the only chance of life is the evacuation of the serum by tapping. This is best done by means of a fine trocar pushed in through the coronal suture, about midway down. The point of the instrument should be directed inwards and backwards, so as to penetrate the lateral ventricle and thus to evacuate a portion of the contained serum. This should be done very gradually, so as not to disturb the circulation through the brain. After a moderate quantity of fluid has been withdrawn, the small aperture should be closed with a strip of plaster, and, if necessary, an elastic bandage be applied round the head so as to compress and to confine the bones; this is more especially necessary in chronic hydrocephalus. It is scarcely necessary to observe that the prognosis in these cases is not of a very favorable character. In *chronic* hydrocephalus the operation can scarcely be expected to succeed, as all the structures, osseous as well as cerebral, have undergone organic changes. In the *acute* forms of hydrocephalus, immediate relief of the coma ensues on the withdrawal of the fluid, and there is just the possibility of the evacuation of the fluid permanently relieving the compression of the brain, whilst the small puncture is not likely to add to the mischief that is going on in the interior of the cranium.

DISEASES OF THE EAR.

Inflammation of the External Ear, Otitis, or Ear-Ache, is usually a rheumatic affection occurring in debilitated individuals, and is characterized by intense pain, generally associated with hemicrania; a kind of combination, indeed, of inflammation and neuralgia. This pain is much increased at night, by warmth of the bed, and is generally accompanied by throbbing and noises in the ear. The *treatment*, at first antiphlogistic, generally and locally, may advantageously, after a time, give place to quinine and iodide of potassium, with the external application of aconite. Occasionally the affection runs on to the formation of abscess in one of the ceruminous follicles of the meatus externus, attended by excessively painful tensive throbbing. To relieve this, leeching, poulticing, and early lancing will be required.

Otorrhœa.—This is a fetid discharge of a muco-purulent character, usually occurring in strumous children, especially during dentition, and often associated with enlarged glands under the angle of the jaw. It may be of three kinds: 1, proceeding simply from the mucous surfaces of the external ear, apparently depending on subacute inflammation of it; 2, proceeding from the middle ear through a perforated tympanum, the mischief extending to and the discharge proceeding from the mastoid cells; 3, connected with necrosis of the petrous portion of the temporal bone, associated with disease and destruction of the tympanum, and necessarily of the internal ear. These discharges are especially apt to supervene in measles and scarlatina. Their prognosis and treatment will depend on their precise seat. When occurring from the external meatus only, however tedious, they are never dangerous. Attention to the state of the general health and to that of the teeth, with the use of lead, chlorinated, or carbolized injections, will usually arrest them. When occurring from the middle ear, through a perforated tympanum, they are far more intractable and also more serious. Not only will hearing be impaired to a greater or less extent, but they may continue for an indefinite time, resisting all means of treatment. If they proceed from the mastoid cells and the internal ear they are far more serious, and the patient is exposed to a double danger. The dura mater covering the bone may become inflamed, and, the membranes at the base of the brain becoming irritated by the extension of the morbid action to them, convulsions, coma, and death usually at last result. This is especially the case when the petrous portion is the seat of disease. When the mastoid process is chiefly affected, phlebitis of the sinuses and the cerebral veins ensues, and pyæmia is developed, which proves fatal.

Special Affections of External Ear.—The external ear is occasionally the seat of special affections; thus, in idiots, *hypertrophy* of this structure is sometimes met with; and in gouty subjects, *tophi*, or *gouty concretions*, are occasionally deposited in it. Paget, Bruck, and Vanzetti have described a *fibrous tumor* that occasionally forms in the lobule of the ear from the irritation produced by piercing it, and as "one of the penalties attached to the barbarism of ear-rings." These tumors are semi-malignant, like the warty growths of cicatrices; and, after excision—their only treatment—are somewhat apt to return.

Bloody tumors, or hæmatomata are occasionally developed in the external ear of the insane or idiots. They may attain a large size, and are often multiple. Unless they become inflamed, I think it better to leave them untouched, when they will gradually be absorbed. If inflamed, they must be opened.

Concretions in the Meatus.—We not uncommonly find that the meatus becomes blocked up by accumulations of wax, dark, indurated, and pipe-like, or forming balls and masses that lie in contact with the tympanum. These chiefly occur in individuals of the bilioso-phlegmatic temperament, and are a common source of temporary deafness among young people. They not only materially impair the sense of hearing, but are very apt to give rise to noises in the head, and to crackling sensations on opening and shutting the mouth. Their presence is best ascertained by examination with a well-constructed ear-speculum; that introduced by Toynbee, of a double convex shape, is the most useful. The *treatment* of these concretions consists in softening the wax by the introduction of a little glycerine into the ear for a few nights, and then repeatedly washing out the meatus by the injection of tepid soap and water, or water containing a little soap-liniment, thrown in with a large

syringe; as the fluid regurgitates from the tympanum, it will at length bring away the dark and hardened ceruminous masses.

Polypi are occasionally met with, situated rather deeply on one side of the meatus. They are usually hard and fleshy-looking, though sometimes soft and gelatinous, as in the nose; sometimes pedicellate, but at others situated on a broad base. They produce serious inconvenience by obstructing the external ear, and require to be twisted off by means of forceps, or, if too firmly fixed for this, cut off with scissors; the surface from which they spring should then be touched with nitrate of silver, so as to prevent a recurrence of the growth.

Thickening of the Cuticle.—Occasionally the cuticle of the external ear, and that covering the tympanum, becomes thickened and indurated, assuming a dull white appearance: this condition may give rise to some amount of deafness. In these circumstances, glycerine, citrine ointment, or solution of nitrate of silver, will be extremely useful in restoring the healthy action of the integument of the part.

Deafness.—It is not my intention to enter into the general pathology of the various kinds of deafness, nor to discuss its causes. It may be stated generally, however, that it may arise from obstruction of the external ear from disease: from ulceration and perforation of the tympanum; from various inflammatory affections, chiefly of a subacute and chronic character, of the internal and middle ear; from paralysis of the acoustic nerve, either local or dependent on cerebral lesions; and lastly, from obstructions in the Eustachian tube, or from disease of the throat. Toynbee has especially shown that many cases of so-called "nervous" deafness, together with singing, ringing, boiling and other noises in the head, are in reality dependent upon chronic inflammatory affections of the internal and middle ear; and that the treatment best adapted for their cure consists in constitutional and local means of an alterative and antiphlogistic character.

DISEASES OF THE NOSE AND CHEEKS.

Chronic Catarrh, in the form of a thin watery mucous discharge, lasting for many months, is occasionally met with, more particularly in young women, independently of any structural disease of the mucous membrane. The *treatment* in this affection consists in the employment of tonics and means calculated to strengthen the system generally, and the local application of astringents, such as tannin, chloride of zinc, &c. But under any plan of treatment this affection is apt to prove rebellious.

A very Fetid Discharge from the nose will occasionally occur in delicate and unhealthy children while cutting their teeth, and may continue for several years. It is not attended by ulceration of the mucous membrane, but appears to be due to some modification of the nasal mucus, connected with protracted and faulty dentition. The *treatment* should be directed rather to the teeth and stomach than to the nose.

Epistaxis, or bleeding from the nose, is very common in children and in young people about the age of puberty, more particularly in girls, antecedently to the menstrual period; it may either be active or passive, but is most usually dependent on congestion of the mucous membrane. But in the adult it is more serious, and may then be associated with and dependent on two very opposite conditions—either on a state of plethora with tendency to cerebral congestion, or on an anæmic and cachectic state, in which the blood is thin, and does not coagulate readily. In the first condition the epistaxis is often connected with congestion of the liver, and, when occurring in the young and plethoric, it is often a salutary relief to the system. But when occurring in cachectic and anæmic people, more particularly in persons advanced in years, it becomes of very serious moment; and in such circumstances the loss of blood may be so continuous and copious that, unless active means be adopted, a fatal termination may ensue, the hemorrhage being truly arterial. When epistaxis proves fatal it is by its constant recurrence. In these cases, I believe, the nasal hemorrhage is always associated with a broken-down and unhealthy state of the blood, dependent upon chronic visceral mischief, especially disease of the kidneys and liver. The worst and most intractable cases that I have seen have been connected with hepatic disease and jaundice.

Treatment.—Epistaxis must not be treated simply as a local disease of the nose.

It is usually only a symptom of some constitutional condition that requires remedying before the hemorrhage can be expected to cease. Hence it is of the first importance to treat on ordinary medical principles those states of plethora or cachexy with which it may be associated, or those conditions of disease of liver or of kidney that are met with in persons suffering from it.

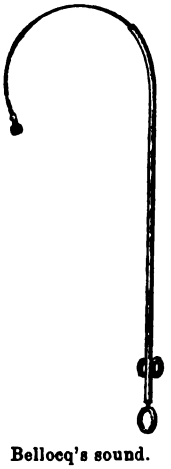
In young people, otherwise healthy, and in slighter cases, epistaxis may commonly be arrested by the employment of ordinary domestic means, such as the application of cold to the nape of the neck and forehead; and its return may be prevented by the use of purgatives, or by attention to the proper regulation of the menstrual function.

In plethoric adults the flow should not be too suddenly checked. Should it prove very abundant, dry cupping between the shoulders, and the application of an ice-bag to the forehead, with rest, will be required.

In anæmic and cachectic subjects, and in old people, the hemorrhage is often attended by dangerous consequences, and requires the use of active measures for its suppression. In these cases the following plan should be adopted. The head should be raised, an ice-bag applied to the forehead, complete rest and quietude enjoined, and gallic acid in ten-grain doses, or half-drachm doses of the tincture of ergot, administered at frequent intervals. Should the bleeding still be profuse and continuous, the interior of the nose may be sponged out with a solution of perchloride of iron or tannin. If this do not suffice, it will become necessary to plug one or both nostrils. This is best done by means of a plug of prepared sponge, having a quill or a piece of gum catheter passed through it for breathing purposes, and soaked in a solution of perchloride of iron.

Should, however, the hemorrhage still continue, the blood forcing its way backwards into the throat, or perhaps being swallowed, the posterior nares require to be plugged as well. This is best done by carrying a long piece of strong whip-cord along the floor of the nose through the posterior nares into the pharynx, by means of Bellocq's sound (Fig. 380), or, if this be not at hand, by threading the cord through an elastic catheter, and carrying this into the pharynx, then seizing the cord as it appears behind the soft palate, and drawing it forwards into the mouth, at the same time that the catheter is taken out of the nostril. In this way the

Fig. 380.



Bellocq's sound.

Fig. 381.

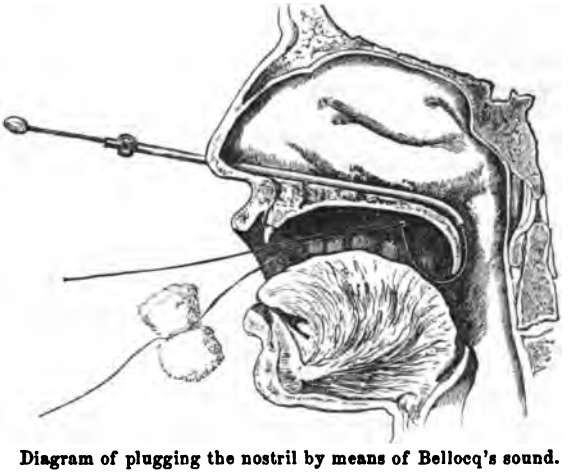


Diagram of plugging the nostril by means of Bellocq's sound.

string will pass through the nose, round the back of the soft palate, into and then out of the mouth (Fig. 381). To the centre of the piece of string that hangs out between the lips, a plug of lint, of about the size of the thumb, or better still, a piece of compressed sponge, should be firmly tied; this is then drawn up into the posterior nares by pulling on the end of the ligature that hangs from the nose, being guided in its passage behind the palate by the fingers introduced into the mouth. When the bleeding has ceased, it may readily be withdrawn by means of the string that hangs out of the mouth. As the epistaxis is very apt to recur, it is a wise precaution, when the plug is removed from behind the palate, to leave a loop of

string in the nose and mouth, which may be knotted and fixed by a slip of plaster behind the ear. In this way the plug may, if occasion occur, be readily replaced without the necessity of re-introducing the sound or catheter through the nose, which is often a troublesome operation.

Chronic Thickening of the Schneiderian Membrane.—The mucous membrane of the nose is not unfrequently chronically inflamed, especially in strumous children; that portion of the membrane covering the turbinate bones becoming thick, soft, and vascular, and projecting like a broad fringe from their surface. It is usually of a bright red color, and covered with muco-pus. This swelling at all times produces snuffling, and a peculiar intonation of voice, but increases in wet weather, and then may become so great as seriously to obstruct the breathing.

The *treatment* consists in attention to the general health; more especially to the eradication of the strumous diathesis. Much benefit may also be derived from the local application or injection of astringents, as a strong solution of the nitrate of silver applied by means of a camel's-hair brush, and sulphate of zinc and oak-bark lotions snuffed up, or injected by means of a proper syringe. In many instances, when the disease occurs in strumous children, change of air will effect the greatest amount of benefit.

Abscess occasionally forms either on the mucous membrane or on the septum, and thus may lead to necrosis of the cartilages and bones, separation of these, flattening of the nose, depression of its bridge, and great deformity. These various forms of abscess, followed by necrosis, are commonly syphilitic, and then are associated with ulcers and a foul and fetid discharge, which has a tendency to cake upon their surface, forming dark and ragged crusts, and constituting the different kinds of *ozæna*. The septum may be the seat of chronic ulcerations consequent upon the irritation of decayed teeth, producing disease of the antrum, and escape of morbid secretion from this into the cavity of the nose.

The *treatment* of these conditions must be conducted by the local application of nitrate of silver, black wash, and the chlorinated lotions; the general treatment consists usually in the administration of the dilute mineral acids, iodide of potassium, and sarsaparilla.

Ulcers and Fissures, of a less serious character, though very painful and chronic, often occur at the angle of the ala and septum, or between the ala and tip. Their *treatment* consists in touching them from time to time with nitrate of silver, or in the application every night of white precipitate or citrine ointment; at the same time that the general health is attended to, cachexy removed, and the strength restored, by the administration of iron, bark, and sarsaparilla.

Necrosis not unfrequently occurs in the loose bony structures lying in the nasal fossæ or in the nasal bones themselves. In these cases the septum nasi participates in the morbid action, and commonly separates or is perforated.

Necrosis may occur in these situations either as the result of syphilis, the abuse of mercury, or from external injury. I have, however, seen cases, more particularly in women and children, which were not referable to any of these causes, or indeed to any other external exciting cause, and in which scrofula was probably the occasion of the disease.

The presence of the necrosis may be suspected from the great fetor that infects the breath—the characteristic odor of dead bone being emitted, but in an excessive degree; and the existence of necrosis may always be positively determined by exploration of the nasal cavities with a probe.

The *treatment* is simple, and must be conducted on ordinary medical and surgical principles. If the general health be impaired, or if the disease be specific, appropriate alterative constitutional treatment must be adopted. The fetor may be lessened by the injection or snuffing up of disinfecting liquids, more particularly the chlorides and permanganates. [Thudichum's douche will be found of great service in all cases attended with an offensive discharge from the nose. The current must of course be directed into the unaffected nostril, or if both be involved, through either alternately.—A.] So soon as the bone is loosened, it must be extracted with polypus forceps, coming away in soft black crumbling, offensive masses. There is often abundant hemorrhage after this extraction, but I have never had serious trouble given in these cases; plugging may possibly be required if cold do not arrest the bleeding.

Lipoma is a chronic hypertrophy of the cutaneous and subcutaneous structures,

only did the disease occur under thirty. This disease is at first entirely local, often being induced by some irritation, as by a rugged broken tooth, or by smoking a clay pipe; and when removed it does not, I believe, very commonly return. At least, of the very many cases that have been operated upon at the University College Hospital, I have only known one patient return with a recurrence of the disease, and I do not recollect any case of secondary affection of this description to have applied to that institution after having been operated on in other hospitals; I cannot, therefore, but come to the conclusion that the operation for epithelioma of the lip frequently rids the patient permanently of disease.

When the glands under the jaw are enlarged in this disease, it is a question whether an operation should be done; but I think decidedly that extirpation of the disease and removal of the enlarged glands (provided that the surrounding soft parts be not involved) should be practised if the patient be in a good state of health, as he will thus be placed in a more favorable condition than before the operation, and will have a better chance of prolongation of life.

Operation.—When once the true nature of the disease has been ascertained, the operation should be performed with as little delay as possible; but before it is done,

Fig. 384.

Epithelioma of lower lip: lines of incision.

Fig. 385.

Lip after removal of epithelioma.

it is well that any very prominent or broken tooth should be removed, and the tartar cleaned away from the incisors. The operation requires to be somewhat modified, according to the situation and extent of the affection (Fig. 384). If this be tolerably limited, a V-shaped cut, extending widely round it, and carried sufficiently low to include any indurated prolongation of the absorbents, should be practised; the edges of the cut should then be brought together by two hare-lip pins with a twisted suture, as in the case of a simple hare-lip. When the disease occupies a considerable longitudinal extent, but does not dip down very deeply, a slice of the lip should be shaved off, including the whole of the morbid structure; and it is often surprising, in these circumstances, to observe how the tissues of the lip will speedily rise to their natural level, thus preventing any material deformity from being left (Fig. 385). In some cases the disease occupies a square surface, and then it is necessary to excise a portion of the lip: when this is done, a considerable gap is left, requiring to be filled by some plastic operation of the kind that will be considered in a subsequent chapter, which may be most conveniently done at the time when the excision is performed. When the disease occurs at the angle of the mouth, it assumes a more intractable character than when affecting the free part of the lip. The same operation—that of free excision—may be applied to it here as in the former case; but with less prospect of success. Should the disease be as extensive as at Fig. 386, the lines of incision must be so planned as completely to surround and to isolate it.

Fig. 386.

Extensive epithelioma of the lip: lines of incision.

DISEASES OF THE PAROTID GLAND.

Parotitis, or Mumps, is a common affection, especially in children, though it not unfrequently occurs in adults. It arises usually from cold and wet, and is frequently infectious. Both sides of the neck are usually affected, and the swelling, stiffness, and pain are often considerable, though it very rarely happens that suppuration occurs, unless it be in the lymphatic glands of the neighborhood. Metastasis to the testicle or breast, though of rare occurrence, has been described as occasionally happening.

The *treatment* of this affection is simple. If it be severe, the application of hot fomentations and leeches, the administration of saline purgatives, and, when the affection is on the decline, frictions with camphorated oil, will hasten its resolution.

Tumors.—Tumors of the parotid gland itself are not so frequent as morbid growths situated upon it or in its vicinity; yet occasionally they consist in an actual transformation of its structure. The tumors met with in this region may be simple or malignant. When simple, they are usually of a *fibrous* nature and often *encysted;* they are hard, deeply attached, but movable on careful manipulation; round, and of very great size, becoming even as large as a cocoa-nut; the skin covering them is thin but not adherent, and not unfrequently a network of veins covers the mass. These growths frequently send prolongations under the ramus of the lower jaw, and then occupy the whole of the space between its angle and the mastoid process; when firmly bound down, they involve the bloodvessels and nerves in this important region, coming into relation with the styloid process and its muscles, with the internal as well as the external carotid, and even pressing upon the pharynx and projecting into the fauces, as was the case with the patient from whom the annexed cut (Fig. 387) was taken. In such cases as these the deep relations of the tumor are so intricate, important, and extensive, that no operation for its removal can be undertaken, and the patient usually eventually dies in consequence of disturbance of the cerebral circulation, or compression of the pharynx and larynx. In consequence of the large size that these tumors may attain, they have a tendency to produce atrophy of the parotid, and often, by interfering with the cerebral circulation, occasion various congestive symptoms about the brain. Besides the fibrous, various other simple tumors, such as *fatty*, *enchondromatous*, and *encysted*, occur in the parotid region. These present nothing remarkable in their course here. In some cases the parotid may undergo *cancerous* infiltration, the tumor then presenting the characters and running the course of the ordinary forms of malignant disease.

Fig. 387.

Fibrous tumor of parotid too deeply seated for removal.

Diagnosis.—It is of great importance to effect the diagnosis between the non-malignant and the malignant varieties of tumors in the parotid region. In the *fibrous*, *fibro-plastic*, *fibro-cellular*, and *enchondromatous tumors*, there is always mobility; and, although the attachments may be deep, the skin is not involved to any extent. The outline of the mass is usually well-defined, square, and somewhat lobulated. The progress of the growth is very slow, often occupying many years before it attains any considerable bulk, as in the annexed cuts (Figs. 388, 389), representing a tumor of sixteen years' standing, which I excised. In the *scirrhous growth* there is no mobility, but the mass is solidly fixed; its outline is ill-defined, the skin soon assumes a reddish-purple color, is brawny, and presents the usual characters indicative of subjacent malignant action. When these tumors are *medullary*, they grow with considerable rapidity, feel soft and pulpy, and are rounded and ill-defined in their outline, especially under the ear and by the ramus of the jaw.

Treatment.—In the treatment of these tumors, extirpation is necessarily the only course that can be adopted; and this, in my opinion, should not be attempted if the disease be malignant; for, as it would be impossible to remove its deeper attachments,

the growth to a certainty would speedily return. Even if the disease be of a simple character, care must be taken that every lobule and prolongation be extirpated;

Fig. 388.

Tumor of parotid.

Fig. 389.

Tumor of parotid: back view.

for, if any be left, however small, it will without doubt become the nucleus of a new tumor. In removing tumors in this situation, the superficial incisions should be free, and either longitudinal or crucial, so that the whole mass may be fairly exposed. It is not wise to remove integument, however redundant this may appear to be, unless it have undergone infiltration, incorporation with the tumor, or change of structure; and even then as little as possible should be taken away. The fibrous or aponeurotic investments of the tumor must be fairly opened, and the edge of the knife must then be directed against it, and the dissection carried on from below upwards, or from behind forwards, so that one division of the bloodvessels supplying it may be sufficient. After the tumor has been well loosened by the division of investing fasciæ and structures (and it is surprising how movable it often becomes after this has been done, though it may previously appear to have been incorporated somewhat solidly with the subjacent tissues), it should be taken hold of by the hand or a large double hook, and drawn well forwards whilst the deep dissection is being carried on. In prosecuting this, the surgeon must particularly guard against wounding the temporo-maxillary artery and the portio dura nerve, which are especially exposed to injury. In some cases the division of these, especially of the artery, cannot be avoided, as they are incorporated in the mass that is undergoing removal. The hemorrhage would then of course be abundant, but may usually be immediately arrested by the ligature of the divided artery; indeed, in most cases the bleeding is profuse, owing to the unavoidable section of nutrient vessels and of large subcutaneous veins, but may generally be readily arrested by ligature and pressure. In most instances, however, by keeping the edge of the knife carefully against the tumor and by drawing it well forward, so as to loosen it in its areolar bed at each stroke of the scalpel, removal of the morbid mass may be effected without the division of any important vessel or nerve. It is of more consequence to avoid a wound of the portio dura or of the chief branches of the pes anserinus, than even of the temporo-maxillary artery; as persistent and incurable paralysis of the jaw would result from such an injury. Injury to this nerve is best avoided by dissecting out the tumor by incisions parallel to its main trunk and chief branches, and especially by drawing the mass well forward, and directing the knife towards it. After the extirpation of some small fibrous or encysted tumors in the substance of the parotid, there is often a great tendency to copious secondary hemorrhage, requiring pressure, or even the application of the actual cautery, for its arrest.

If the tumor, though non-malignant, have been allowed to attain an enormous size, developing at its deeper attachments as well as superficially, with large

lobes lying behind and under the ramus of the jaw, in close relation with the pharynx, the internal carotid, and jugular vein, it would not be prudent to attempt its removal.

Excision of the parotid gland itself is occasionally spoken of, but is very rarely if ever done. I believe that in most, if not all, the cases in which it is stated that complete removal of this gland has been accomplished, tumors overlying and compressing it have been mistaken for it. It is evident that a diseased parotid could not be removed without the division of the external carotid artery and facial nerve.

[So many cases have been reported by competent observers where the parotid gland is said to have been excised, that it is scarcely reasonable any longer to question the possibility of the operation. At the same time there can be no doubt that, as the author says, tumors exterior to the gland have frequently been mistaken for that organ itself, and extirpated by surgeons who honestly believed that they were excising the parotid.—A.]

TUMORS OF THE NECK.

Growths, Simple and Malignant.—Besides tumors in the parotid region, *fatty*, *fibrous*, *glandular*, and *encysted growths* are not unfrequently met with in the *submaxillary space*, and in the *triangles of the neck*. In these situations they may occasionally attain a considerable size, though they seldom extend very deeply, being superficial to the deep fascia. Hence, when the integuments and superficial structures covering such a growth are divided, it may be insulated with considerable facility, its fixity being in a great measure due to its being bound down by the investing fascia, rather than to its having contracted deep adhesions. Occasionally, though rarely, a slowly growing tumor develops deeply in the anterior triangle of the neck, lying between the sterno-mastoid, the trachea, and the pharynx, possibly even under the carotid sheath, with the artery pushed on one side, or even running over the anterior convexity of the growth. In such cases, the question of removal requires to be approached with the utmost caution. If the tumor be movable above the vessels, it may generally be taken out; if it lie below the sheath, even though not fixed to the spine, its extirpation is not practicable. Before determining upon the removal of a tumor situated in one of the triangles of the neck, it is indeed always very necessary that a diagnosis be effected of its nature, and that some opinion be formed of the probable extent of its deep attachments.

The first point to ascertain is, whether it be simple or malignant. If simple, it will usually have been many years in growing; it will be hard but not stony, lobulated or somewhat square-shaped; the patient's general health being good. It will generally be found to be movable, though not perhaps to any great extent, and will present no sign of incorporation with neighboring structures; the fibres of the platysma will not appear to spread over it, and the sterno-mastoid muscles may be traced to one side of or below it. In such circumstances, removal of the tumor may be undertaken by any surgeon possessing a fair share of anatomical knowledge and manual skill, with every prospect of success. But if the tumor be of stony hardness, have implicated the skin, and be immovable, the whole head being moved on any attempt at drawing it aside; if it be ill-defined under the jaw and ear, and rapidly growing, soft and pulpy to the feel, deeply seated under the angle of the jaw, evidently below the platysma and deep fascia of the neck, and possibly beneath the sterno-mastoid, then no attempt at extirpation should be undertaken, as the mass could either not be removed with safety, or, if it were by any possibility extirpated, the already existing contamination of the neighboring parts would certainly lead to a speedy recurrence of the disease. In removing *submaxillary tumors*, a free superficial incision nearly parallel to the margin of the lower jaw, but below this, will usually allow ready extirpation of the mass. In these operations the facial artery is generally sufficiently under cover of the bone to escape injury, but there may be, and usually is, free venous hemorrhage.

Hydrocele of the Neck.—A peculiar cystic tumor, hydrocele of the neck, has been described by Maunoir and Phillips. The disease usually appears in the posterior inferior triangle, forming a rounded tumor, smooth, tense, and elastic, unilocular in some cases, multilocular in others, and filled with a yellow or chocolate-colored sero-albuminous fluid. It may attain so large a size as to interfere with

The skin covering this tumor is not discolored, in some cases of natural thickness, in others thin and expanded, so as to give a bladder-like appearance to the growth.

The *treatment* of this tumor consists in tapping, when complete collapse of the cyst takes place; which, however, will soon fill again. A permanent cure may be effected by injection with iodine, or by passing a seton across.

True Hydatid Tumors will sometimes form in the neck. A woman was under my care at the hospital for a hydatid tumor of the liver, which I tapped; seven years afterwards she presented herself with a thin wasted elastic semi-transparent tumor in the posterior inferior triangle of the neck, about the size of an orange. This I tapped, and found it to contain clear serous fluid, with the remains of echinococci. In another case, that of a lad aged about 18, otherwise healthy, I removed a hydatid tumor as large as a shaddock from the nape of the neck, where it was deeply seated under the trapezius, growing apparently from the substance of the complexus or splenius capitis muscles, and lying close upon the cervical spine and the occipital bone.

Enlargement of the Lymphatic Glands of the neck, terminating either in chronic induration or in abscess, is of such common occurrence as to constitute perhaps the most frequent form of glandular enlargement. The tumors thus formed present nothing peculiar in their progress or treatment when occurring in this situation; except that when abscess forms it should be opened early by a small incision, and in such a direction, corresponding to the natural folds of the skin, as to leave as little scarring as possible.

BRONCHOCELE.

The thyroid gland is subject to various chronic enlargements, which commonly go by the name of *bronchocele*. These may be divided into four distinct forms.

1. **Simple Hypertrophy.**—The thyroid gland may be simply hypertrophied, and may then attain a very considerable size; in some cases forming an immense lobulated tumor on the forepart of the neck, such as is met with in various districts of this country and of the continent, more especially in the valleys of the Alps, in which the disease is and has been endemic for ages.[1] In the majority of instances, however, the tumor is of but very moderate size, commencing at first as a mere fulness and uniform or rounded enlargement of the isthmus, or of one of the lateral lobes of the thyroid gland, and gradually increasing, until perhaps, by the pressure of the growth confined between the sterno-mastoid muscle and the deep structures of the neck, the voice becomes croaking and harsh, and respiration and deglutition seriously affected. There is a remarkable connection between tumors of the thyroid gland of this kind, and a general anæmic condition of the system. In London nothing is more common than to find a certain degree of bronchocele in pale and bloodless women and girls; indeed, so frequent is the coincidence that it is impossible not to regard it in the light of cause and effect. Great prominence of the eyeballs is frequently associated with these conditions. In practice we constantly observe this triple pathological sequence, viz., anæmia, exophthalmos, and bronchocele; and the connection of these has been commented on by Graves, Basedow, Sichel, White, Cooper, Aran, Begbie, and numerous other practitioners.

Fig. 390.

Cyst of thyroid, containing clear serous fluid.

2. **Cystic Bronchocele** is owing to the development of cystic tumors in the thyroid gland, either associated with or occurring independently of, general hypertrophy of it. These cysts may be single or multiple. When single or of large size, as in Fig. 390, they usually contain clear serous fluid. When multiple, they are filled with a dark, grumous, bloody-looking fluid, and have often cauliflower-like excrescences projecting into their interior. They appear to be of the nature of hæmatomata, and occur independently of anæmia in persons otherwise perfectly healthy, more commonly in young women.

3. **Pulsating Bronchocele** is occasionally met with. The

[1] Quis tumidum Guttur miratur in Alpibus?

which it is to be taken; and if it seem to raise the lid enough, and not too much, it is cut away with scissors to just that extent, and an oval wound is left. The loose and vascular skin of the lids will very soon heal without the application of sutures.

[Ptosis has occasionally been cured without operation by the endermic application of strychnia; this plan might be tried with such patients as have an unconquerable repugnance to the use of the knife.—A.]

Tinea Ciliaris is very common, but only among the very poor. Great cleanliness is required. The eyelashes should be kept cut as short as possible, for the better application of any ointment or lotion that may be prescribed, and for the more effectual removal by bathing of any accumulations of discharge from the edges of the lids. In *chronic* cases these dried accumulations should be at once removed by bathing and wiping, or with forceps, and, the lashes being cut close with scissors, the excoriated parts beneath lightly touched, at intervals of a week, with the solid nitrate of silver. The edges of the lids should be kept greasy always, meanwhile, with the citrine or some other ointment.

Trichiasis.—*Trichiasis* is an ingrowing of some of the lashes, as distinguished from *entropion*, which is an inturning of the whole lid. In both, the lashes are in contact with the globe of the eye; but in entropion the lid may be temporarily rectified and held in its place, and the lashes are not then turned in; whereas in trichiasis the eye cannot be freed from the lashes that are in contact with it without the lid being drawn away, apart from the globe of the eye, as it is abnormally in *ectropion*.

Causes.—Of the causes of trichiasis the commonest is, perhaps, the treatment of "granular" conjunctiva by solid caustics applied too exclusively to the lining membrane of the lid just within the margin, whereas they should be, at least equally, applied far back. (In these cases entropion and trichiasis are often combined—see "Entropion"). Vascular nebula and pannus may then be very probably a result; first, of the granular conjunctiva, and, secondly, of the superinduced trichiasis. It is, perhaps, because granular conjunctiva chiefly affects the upper lid, that trichiasis most often occurs in it. As to the so-called *distichiasis*, the disease has no real existence; there are no cases in which two rows of lashes exist separately.

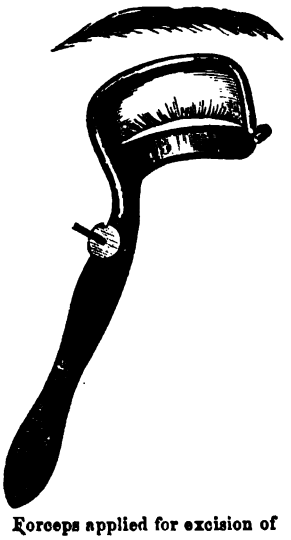
Cases of trichiasis vary so much, and the modes of operating are necessarily so various, that only a few of the operations can be here detailed, and a few practical facts noted. The practice of pulling out the ingrowing eyelashes is worse than useless; because they only grow again, the hair-bulbs being left. The case is therefore only temporarily relieved, and, in the end, vascular nebula of the cornea and consequent blindness are produced by the constant mechanical irritation of the inverted eyelashes. Lashes should only be pulled out as a temporary expedient. Patients sometimes come to the hospitals, almost blind, who have been taught by surgeons to practise the pulling out of their ingrowing lashes; they have done it for years, they have their own tweezers and looking-glass for the purpose; they are relieved each time *temporarily*, but, far from being cured, are always by little and little becoming worse. Again, they not unfrequently break off the lash, and then the broken end causes more irritation and pain than the whole lash had done before. An eyelash, when it is to be pulled out, should be properly seized, near the skin, with broad and rough-ended forceps, and very steadily drawn in the direction in which it grows. But a patient will twitch it out quickly with his tweezers at right angles to the direction of the growth of the lash, and so it is very liable to be broken off.

If only one or two lashes grow in, they may be pulled out, once or twice, in the hope they will not grow again nor again be so misdirected. But if many lashes grow in, or if a few only be always growing in, they must either be excised with their hair-bulbs, or an attempt must be made, by producing cicatrization, to give a right direction to their future growth. The latter operation, being more tedious and less certain in its results, is not worth performing, except on young persons or those to whom personal appearance is important. When the hairs and hair-bulbs are extirpated, the whole row of lashes of each lid operated on should generally be removed, though some only here and there be inverted, unless those which are turned in be all at one part of the margin of the lid. In such a case, a small round piece of all the structures down to the cartilage may be excised, *close to the edge of the lid*, so as to expose the roots of the inverted lashes, and the lashes drawn outwards with fine sutures; after which the scar may effectually evert the ingrown lashes.

If the whole row of lashes, or, perhaps, even if some all along the edge of the lid be growing in, a similar operation to that last described, but extending the whole length of the margin of the lid, may be done. If this should fail, the lashes may afterwards be wholly extirpated. The excision of a part of the row of hair-bulbs is very often unsatisfactory, because the subsequent cicatrization at the extremities of the wound will often draw in and invert some of the nearest lashes of those lately rightly directed.

Excision of hair-bulbs is thus done. A forceps (*compressorium*), having for its lower blade a slightly curved plate of metal, has this blade placed under the lid, between it and the globe. The other blade, the skin of the lid being drawn away from its margin, is then brought down upon the outer surface, and is screwed down, so as to steady the eyelid between the two blades and it just firmly enough to control the bleeding, which in any operation on the eyelids is liable to be considerable and troublesome. This upper blade, to admit of operating, unlike the lower one, is but a skeleton, leaving all the centre of the lid and its margin, on the outer side, exposed (Fig. 391). With a scalpel, two incisions are made along the margin of the lid, one on each side of the row of eyelashes, carefully including all of them; the knife, for both incisions, being held in the direction of the growth of the lashes and made to cut deeply. The ends of the incision are curved into each other, and then the piece of skin, &c., including the lashes, is detached altogether with scalpel and forceps. The inner of the two horizontal incisions is the important one. It must be made, with a firm hand, within every ingrowing eyelash, but in a regular curve, so as not to make an irregular edge to the lid. This incision often carries away with it a longitudinal strip of the cartilage, which gives shape to the lid. It should not trench on the conjunctiva or on that aspect of the lid. Then, if any of the bulbs have been cut through and are left, they should be removed: they are easily seen in the wound as little dark points. No sutures are necessary; the skin of the lid is abundant.

Fig. 391.



Forceps applied for excision of hair-bulbs.

Symblepharon.—When the palpebral and ocular conjunctivæ or the margins of the lids have become united, the bands may be divided, and, to hinder their reuniting, their cut surfaces may be touched with nitrate of silver, oiled lint interposed, and a probe passed between the wound occasionally. But, unless a probe could be, in any such case, in the first instance passed freely under the bands, so that they may be isolated, they will probably reunite to such an extent, that the operation will have been almost useless. A better plan, perhaps, than dividing the band, is to tie a strong ligature, passed beneath such a band, around it, and then let it drop out in the course of time. If a probe cannot be passed under and around the adherent surfaces, or union of the edges of the lids, it is sometimes, first of all, advisable to pass a few silk threads, to be secured and left for some weeks, so as to make a fistulous track which shall be the limit to which it is intended to free the lid, when the parts united are afterwards cut through.

Entropion.—If, in a lax state of the lids, as when a patient has lately become thin, anything should excite the action of the orbicularis muscle, those fibres next the edge of the lid not unfrequently cause it to become rolled inwards; and then the irritation of the lashes against the ocular conjunctiva tends always to aggravate this state of the parts, set up, accidentally as it were, in the first instance, by some other irritation. This abnormal condition is most commonly seen in the lids of old people, and especially in the lower lid, which is kept out less than is the upper lid by the convexity of the globe of the eye. For instance, it is a not unfrequent occurrence, and must be looked out for, and at once remedied if it occur, after the operation for senile cataract. The lids of old people contain but little fat, the skin lies in many folds, and, after an operation, the skin of the lid is bathed in tears, and so the more easily becomes inverted; very often, too, water-dressings are applied. Some slight irritation or pain produces—voluntarily or involuntarily—an extra contrac-

tion of the orbicularis, and the edge of the lid is tilted inwards. Though the irritation of the lashes is, in these cases, very much less than might be expected, and is not at all comparable to that arising from trichiasis or entropion in younger persons, in whom the lashes are stiffer or grow irregularly, the orbicularis is stronger and the lid altogether firmer; it must be closely looked for and prevented. The patient should be taught, when the inversion occurs, to put his finger on the skin of the lid, and so pull it down and replace the inverted edge of the lower lid and the lashes. Very probably, however, this will not be sufficient; and then, the skin of the lower lid being drawn down and well dried, some collodion should be painted along the edge of the lid with a large brush, and the parts kept still until it is dried. If this be insufficient to remedy the abnormal condition, the following operation, applicable also to many cases, otherwise originating, in which the skin of the lid is abundant, should be done. An oval piece of the skin of the lid, *quite close to the margin*, must be excised horizontally. As much as is sufficient of the skin and subcutaneous tissue is seized with toothed forceps, raised a little, and cut away with scissors curved on the flat. The lid is drawn open a little and steadied by the finger of an assistant, or by the little finger of the left hand of the operator, which holds also the forceps. Then all those fibres of the orbicularis nearest to the edge of the lid are snipped away with the scissors, so that the cartilage is quite exposed. No sutures are required, as a very speedy union of the edges of the wound is not desirable, and a broader, firmer cicatrix is obtained by a slower process of healing. Enough of the skin should be removed, and all the inner fibres of the muscle causing the inversion.

More difficult, because more complicated cases, of older date and yet of common occurrence, are those in which the lid, its cartilage, &c., is altogether thickened, generally as a result of the application of caustics in the solid form to the palpebral conjunctiva longer than was needed, probably for granular conjunctiva, or, as usual, too much near to the margin only of the lid. The upper lid is the one most frequently affected. This is the commonest cause of trichiasis; but it may result in entropion, or in both together. The trichiasis must be treated by excision of the hair-bulbs, or otherwise, as may be required. The entropion may be remedied in this, and in such cases of thickening of the lid, by grooving the outer surface of the length of the cartilage, near its margin, by first exposing it, and then making two longitudinal vertical incisions into the cartilage two-thirds or more through its thickness, inclined to each other, so that they meet below and form a V-shaped groove along the edge of the lid. Then, if there be no wrong direction in the growth of any of the lashes (trichiasis), but only the regular row is carried in with the inverted lid against the eye, a few fine sutures are introduced through the skin of the edge of the wound, next the margin of the lid, and then through the edge of the groove in the cartilage, farthest from the lid's margin. If the lashes have been removed for concomitant trichiasis, the fine sutures are merely put through the two lips of the skin wound, so as to approximate the sides of the groove in the cartilage, and keep out the incurved margin. In some cases of entropion, an operation, the reverse of that sometimes adopted in cases of ectropion, the V-Y-operation, may be done. A Y-shaped incision may be made through the skin and subcutaneous parts of the (lower) lid, and the point of the angle, being dissected up, is extended beyond the point from which it was taken, and then secured with some fine sutures.

Ectropion.—For this morbid condition, and, in a less degree, for entropion, it is not possible to point out single operations as a cure. Neither of them is a disease, but the result of various diseases; and even though two cases of ectropion, for instance, may be considered due to the same disease, they will very probably call for very different methods of treatment. Some operations in these cases are often, however, applicable in a general way, as the disease which has been their origin is common to them. In thin old people, who have been stout, a weak orbicularis muscle, with loose skin, induces passively, on any slight provocation, ectropion of the lower lid, and perhaps also consequently lachrymation (which always aggravates the eversion of the lid—see "Slitting the Punctum," p. 832). The very existence also of the ectropion in time only aggravates the disease by exposure, and consequent thickening of the conjunctiva. A tendency to entropion or ectropion may often be remedied by means which in a normal lid would produce the contrary results. Thus caustics too freely applied to the conjunctival surface of the margin

of the lid, it has been said, have often caused entropion. So also, if sufficiently used, the application of nitrate of silver, or some other caustic from time to time, will sometimes cure a slight ectropion. It has been said that a weak orbicularis induces a passive ectropion; and also that a removal of some too powerful and active fibres of the same muscle, next the lid's margin, will cure many trifling cases of entropion. Severer cases of old and confirmed ectropion will probably require to be treated by a V-shaped excision of a part of the whole thickness of the lid: the cut surfaces being afterwards brought together, and adapted with entomological pins and silk twisted around them. Ectropion generally occurs in the lower lid; entropion (in the cases in which there is thickening and perhaps trichiasis) generally in the upper lid, being there artificially produced. Ectropion, from deficient power, or paralysis, of the orbicularis, by force of gravity, and entropion, from excessive action of the marginal fibres of the same muscle, as explained already, both affect the lower lid as a rule.

OPERATIONS ON THE TEAR PASSAGES.

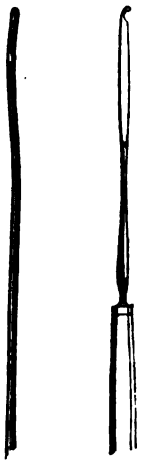
Slitting the Punctum and Canaliculus.—In any case in which, without any special exciting cause, the tears are found to run down the cheeks, this state of things must be, if possible, remedied, or it aggravates itself. In the first place, in operating here, we have to observe, first, if the lower punctum be rightly placed in contact with the globe of the eye; second, if it be patent; thirdly, if the canaliculus or nasal duct be obstructed. Seldom, if the punctum be averted from the globe, will it be enough to restore its right position. Whilst disused, it has become permanently too narrow. If it be everted a little, it will be enough that the punctum be divided, so that the tears may reach the slit-shaped artificial opening. If it be closed, or too small, it must be slit up; and if the canaliculus or nasal duct be obstructed, it must be thenceforth repeatedly probed.

Among the preliminary "special exciting causes," besides grief and casual external stimulants, such as peat-smoke, we must not omit to search for eyelashes, or other foreign bodies, in or upon the conjunctiva. If there be intolerance of light, there is generally an equal amount of lachrymation when the eyes are exposed to light. Both are excessive in the common conjunctivitis of weakly children. Probably, even though the cause of the weeping be but temporary—swelling of the parts near the orifice during conjunctivitis, or abscess of the margin of the lid everting the punctum—it will be best to slit the inferior canaliculus. And as to the slitting operation, it may quite safely be done in any case, even if only temporarily required; for, if it does no good afterwards, it does no harm, and the imperfection of the punctum seems to be of no more serious importance than is that of the pupillary aperture after an iridectomy that was needed and then done. As the lower lid is of the two the most subject to ectropion, so also it seems that the lower punctum is the more frequently everted, obstructed, or obliterated. Gravity is perhaps concerned in both. The surgeon's attention is seldom called to the upper punctum; if it be too small, altogether absent, or abnormally placed, perhaps he is not called on to discover the fact; but, on examination, the punctum is generally found to be in right position and patent, and yet insufficient to prevent lachrymation when the lower punctum, to which the tears gravitate, is not fit to receive them, or the canaliculus to convey them away. If the lower punctum be so much everted that for any length of time it is dried, it probably becomes narrowed, and would not carry away the tears, even if the ectropion were remedied and the punctum again moistened.

Operation.—The patient is seated in a chair, in a good light, with his head thrown back, a towel over it, and resting on the chest of the operator, who is standing behind him. A finger or the thumb of the left hand is placed lightly on the lower and outer part of the skin of the lower lid, which is drawn forcibly down and outwards, and fixed by pressure on the malar bone sufficient to overcome the force of the orbicularis. If the punctum be not everted, so that it may be fairly seen, it is well exposed to view by slight traction with another finger on the skin of the inner part of the lower lid, drawing it downwards a little and fixing it in that position. If the skin of the lower lid be wet with tears or greasy with ointment, it should be first of all wiped dry; or a corner of the towel may be required to be applied between the fingers and the eyelid. The knife employed is very narrow, and about an inch in length altogether. It ends in a small probe, of about a line in length, with a

slightly bulbous extremity, bent somewhat towards the cutting edge (Fig. 392 *b*). It is held with the probe-point turned downwards and directed into the punctum; and, when the surgeon is sure of its being in the right position, some little force may be employed, if necessary, for its passage through the punctum. If the punctum be quite obstructed or disguised, it is well to be as sure as possible that the knife is rightly directed; if little pits be made in the soft skin or conjunctiva with the probe-end, it is so much the more difficult afterwards to make sure of the real position of the punctum. A minute depression, made slit-shaped by traction on the skin of the lid, will be detected in the right anatomical position of the punctum, even if it be quite impervious to the tears. The right position may be judged of by relaxing for an instant the dragging force, and, if the lid be bathed in tears, it may be wiped dry, and a very little quantity of the tears may be detected lying in the natural pit or oozing from it. The probe-point being within the punctum, the knife is turned half-round, so that the cutting edge is directed upwards and towards the nose, and the probe-end, which is not in a line with the rest of the instrument, is directed in that which, anatomically, is known to be the direction of the canaliculus. This is then slit up, as far as the probe-end will let the knife go, towards the nose, or, at least, well into that part of the palpebral conjunctiva in which the tears habitually lie. The nasal duct may now be probed if necessary. If a little clot of blood lie between the edges of the wound, it is no disadvantage, as it will hinder their reunion. A day or two after the operation a probe should be passed along forcibly between the edges of the wound to tear through recent adhesions, if they have formed. After this, they will remain apart; perhaps not throughout the extent of the incision, but sufficiently far from the punctum to gain all the advantages to be desired of the operation, whether for the admission of tears to the sac and nasal duct, when they are in a healthy state, or for the entry now and then of a probe to be passed along the latter channel if it be obstructed. A small piece of the inner lip of the slit-up canaliculus has been sometimes removed with advantage, when there is eversion of the edge of the lid of an amount and kind which would suggest it. It is easily done, the lid being fixed and drawn down and outwards, with forceps and scissors.

Fig. 392.



a *b*

a. Bowman's probe (No. 6) for nasal duct. *b*. Knife for slitting canaliculus.

The upper punctum seems to be alone generally insufficient. I do not remember to have slit it up usefully but once, in a case (*Ophthalmic Hospital Reports*, vol. iii. p. 4) in which the lower orifice could not in any way be found in the dried mucous membrane. The upper punctum was in no way abnormal, and, when slit, I passed a curved probe by it into the sac and back by the lower canaliculus so as to make it emerge at the lower punctum. Then the lower punctum could be slit as usual, and the case was cured forthwith. The upper punctum and canaliculus, even if slit, unfortunately do not make a convenient way for the probing of the nasal duct, because of the projection of the brow; and the upper channel alone, even if rightly placed and patent, does not prevent lachrymation, or at least very often fails.

In *acute inflammation or abscess of the lachrymal sac*, the lower canaliculus must be slit, and the matter, if any, thereby let out on the conjunctival aspect of the lid. A new difficulty in this case presents itself in the firm swelling of the soft parts of the neighborhood of the sac, which makes it very difficult to obtain a view of the punctum so as to introduce the probe-ended knife. This may generally, however, be done by pressing the point of a finger or the end of the handle of a scalpel into the œdematous tissues just outside the right position of the punctum, so as to evert it, although the whole lid cannot be everted or drawn aside. An abscess of the lachrymal sac, if neglected, will open through the skin, and leave a permanent scar, but in no case should it be opened externally. A fistula lachrymalis is understood to mean a permanent opening externally, leading down to the lachrymal sac, not to the gland. It is not an uncommon result of neglect of obstruction of the nasal duct. Inflammation of the sac arises, and goes on to suppuration; and, this being neglected, the abscess opens externally through the skin. The pain being relieved, the disease is probably still neglected, and a fistulous opening is established. A scar cannot then be avoided; but a fistula in this situation may generally be induced to heal, if

the nasal duct be diligently probed and the natural outlet of the tears re-established. Whilst there is discharge, it may be well, by the use of a small syringe introduced by the fistulous opening, if it have not begun to contract, or by the slit-up canaliculus, to inject tepid water from time to time.

Probing the nasal duct.—The punctum admits only so very small a probe, that, when the nasal duct is in any way obstructed, it must be slit up as described. Thenceforward a sufficiently large probe can be passed, when it is required, to act as a bougie to overcome such slight obstructions as not unfrequently are the cause of the enduring lachrymation, or, it may be, of the subsequent serious inflammation and suppuration within the lachrymal sac; to evacuate the muco-purulent matter, and then afterwards to obviate the obstruction by slow degrees. Bowman's probes are of six sizes. Fig. 392, *a*, represents the largest, No. 6, of the actual size. It is the most useful size, and, although very often it cannot at once be passed through the nasal duct, we always aim at so doing in the further treatment by probing of any such case. Lachrymal probes (for the nasal duct) have two slight bends at perhaps one-third and two-thirds of an inch from the end, the one bend being made at a quarter turn from the direction in which the other bend is made. By having these different bends, the end of one of these probes will so much the better find its way and pass along the nasal duct, either unassisted, held loosely in the fingers, or being slightly rotated by the surgeon as it is pressed downwards. The patient being seated with the back of his head against the chest of the surgeon, the probe is held horizontally in the right hand for the right eye, and *vice versâ;* with one finger of the other hand the skin of the lower lid is drawn down and outwards, as in the operation of slitting the canaliculus. With another finger, the skin of the same lid is drawn down a little just at the punctum, so as thus to evert the lid and show the orifice by which the probe is entered, the point of it being kept down a little, so as to feel the bottom of the open mucous channel as it is passed along; and, the parts being stretched at the same time, it is hardly possible to make a false passage. The probe is known to be in the sac by the resistance that is felt, and the absence of any elasticity; and, when the lower lid is no longer kept on the stretch, pressing the end of the probe inwards towards the nose, if the probe be in the sac, does not pucker the skin of the parts concerned. If the probe have met with any obstruction in the canaliculus, if it have folded the lining membrane and cannot therefore pass, it should be withdrawn a little and then passed onwards again, so as to make sure that it is in the right direction; then, by steady pressure, with slight rotation of the probe, the obstruction may be soon overcome; if not, a smaller and a smaller probe must be used until one is passed. Then the size of the probe is noted, and each succeeding time a larger one is attempted to be passed. It may be well, perhaps, to leave it in a short time when it is passed through a stricture.

The probe, having been introduced into the lachrymal sac, has yet to be passed along the nasal duct. To do this it is very necessary to proceed in no uncertain way, or many difficulties may yet be encountered, and a false passage made. The point of the probe, now in the sac, is against the bony inner wall. It must be held there whilst the probe is brought up from the horizontal to the vertical position. It will then, at least, begin to pass along the nasal duct, if it will not traverse the canal. The direction of the nasal duct—downwards, backwards, and inwards—being borne in mind, the probe is gently pressed on; it must not be held so tightly between the fingers that it cannot follow the course of the duct, and sometimes, it has been observed, a slight rotation by the surgeon's fingers will facilitate matters. If it will not pass down to the floor of the nostril, perhaps an inch and a half, a little more pressure may be exerted and continued, and increased if the probe seem to pass at all. The probe generally passes easily enough through the lower part of its course. Experience alone can determine when and how much pressure may be exerted without fear of making a false passage.

For stricture in the bony nasal duct, it is perhaps useless to leave the probe in for a short time, as may be done for the strictures of the canaliculus above described. It should be removed when it has passed all along the duct. It must be passed again many times at intervals of a few days, and the size, up to No. 6, increased, if at first it have not been possible to pass the largest probe. If after the obstruction has been remedied, as very often happens, the stoppage again takes place (the punctum and canaliculus are now always patent), recourse must be again had to the probing. The smaller sized probes are liable to be caught in folds of the mucous

membrane and to make false passages; and No. 6 (or 5 or 4) by a little pressure in the right direction, and with all due precautions, will almost certainly pass.

SQUINT-OPERATIONS.

In these operations the object is, by dividing the tendon of the muscle which produces the strabismus, to cause it to become attached to the globe of the eye at a point behind its natural insertion into the sclerotic. Then the muscle regains and retains the power of moving the eye, but in a diminished degree, so as, usually and without any special exertion, to place the eye in a position parallel to that of the other. The first point in diagnosing a fit case for tenotomy in squint cases is to ascertain that all the muscles of the eye act, and that there is no paralysis of any of them. Then, again, an operation should not be performed in any case in which the squint is not confirmed, where sometimes there is no degree of squint; in such a case, spectacles should be tried.

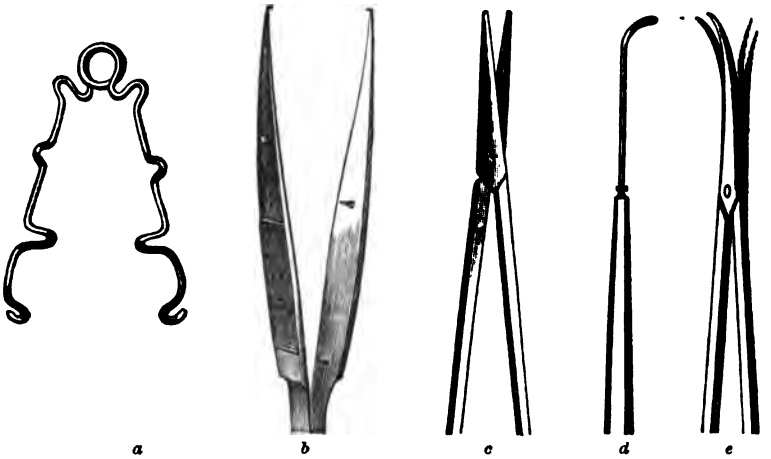
To ascertain the existence or the degree of squint, the patient is placed standing before the surgeon, who observes which eye seems to squint. The surgeon, if, for instance, the patient's right eye be turned inwards in looking at him, extends and closes the fingers of his right hand, bringing them with the back of the hand to the face of the patient, close up before his left eye, without touching it; then, the patient still regarding the face of the surgeon, the left eye being shut out, the right eye is everted from its former position and turned out sufficiently to continue the steady gaze of the patient in the face of the surgeon. The surgeon now removes his hand quickly from before the left eye, and this is observed to be turned inwards, as the right was; probably it now quickly rights itself, and, as at first, the right is again inverted. Or the surgeon, if the right eye do not now seem to be again turned in, uses his other hand, and excludes, without closing, the patient's right eye, to see, as the latter is always looking steadily in his face, if the other will now seem to correct itself; and so he proceeds, successively and alternately, to confirm his diagnosis. It is very improbable that, if there be some degree of convergent strabismus, even though not constant but recurrent, it will not be manifested when the patient is under the excitement of a formal examination, and is regarding a rather near object, the face of the surgeon. If there be no squint, and the previous diagnosis was in error, whichever eye is shut out in the way described, the other will not move or change its position, for it continues to look at that at which it was desired to look.

If we desire to estimate the *degree* of strabismus, the patient is desired to look straight before him at any object. A little mark is then made on the skin near the edge of the lower lid of the wrongly-directed eye, at a point vertically corresponding with the outer (or inner) edge of the circumference of the cornea. Then the other eye of the patient is closed with the hand, and the patient, without turning his head, is desired still to regard the same object. The squinting eye is then righted; and another mark, again corresponding to the same part of the margin of the cornea is made on the lower lid. Then the distance between the two marks is measured, and the squint is said to be of so many lines. If, in a case of convergent squint, the interval is of as much as three or four lines, it is probably advisable that the tendons of both the internal rectus muscles should be divided at once, rather than that alone of the eye only ostensibly squinting. In the more common and less degrees of convergent squint, it is best at first in each case to divide only the internal rectus tendon of the eye habitually inverted, and to divide the other afterwards only if the first operation should prove to be insufficient. To determine which eye is to be operated on, close attention to the patient, for a short time, covering neither eye, will generally be enough; or both eyes of the patient may be repeatedly covered for a minute and uncovered with the hand of the surgeon, so as better to observe which eye is habitually turned in. As to repeated divisions of the same internal rectus tendon, when the eye has persistently remained inverted, experience is rather unfavorable; but if without it the defect be not remedied, it must be done, supposing, of course, that the opposite internal rectus tendon has been cut.

Operation.—The operation for squint is thus done. A wire-speculum (Fig. 393 *a*), is inserted between the lids, which are thus widely opened. [What is known as the *stop* speculum should always be used in preference to the old-fashioned spring specu-

lum represented in the figure.—A.] A small fold of the conjunctiva is then seized with toothed forceps with fine points (Fig. 393 *b*), just below and a little in front of the insertion of the rectus tendon to be divided; with straight and rather blunt-pointed scissors (Fig. 393 *c*), this little fold is cut through horizontally; the forceps

Fig. 393.



a *b* *c* *d* *e*

a. Wire-speculum. *b*. Toothed forceps with fine points. *c*. Straight scissors. *d*. Strabismus-hook. *e*. Scissors for dividing optic nerve in extirpation of the eye.

is then inserted, closed, rather deeply in the wound, and a fold of subconjunctival tissue, fascia, &c., is pinched up close to the sclerotic, and divided with the scissors on its sclerotic side. Now, the forceps still holding that which was last taken up with it, the points of the scissors being still pressed against the sclerotic, and each time very little opened, a succession of little snips is made, the scissors being pushed backwards to some little distance beyond the insertion of the rectus tendon and below the muscle. When none of the fascia in this tunnel-like opening remains uncut the scissors are withdrawn, and remembering the direction of the deep little opening just made, and observing that the eye has not changed its position, or, if it have moved, allowing so much for the change of position, the strabismus-hook (Fig. 393 *d*) is quickly inserted and carried directly backwards through the length of the opening in the conjunctiva and subconjunctival tissues, and then, the point being always kept close against the convex sclerotic, the handle is depressed, and the hook passed upwards under the tendon of the muscle to be divided, and brought forwards up to its insertion. The points of the scissors are then carried along the sclerotic side of the hook, and opened a little, so that one blade passes with the hook under the tendon, and the other in front of it. This blade will pass beneath the conjunctiva without penetrating it, or if it be too closely adherent, the two blades of the scissors, closed, may, before dividing the tendon, be made to open a way in front on the insertion of the tendon. The tendon is then cut through; the hook being at the same time everted a little to allow one blade of the scissors to pass between it and the sclerotic. The scissors' blades are opened as little as may be required, so as to prevent any unnecessary disturbance of the parts, or tearing open of the external opening. An inexperienced operator is liable to be misled by a want of knowledge of the feel of the sclerotic, when it is reached as the hook is passed along beside the globe upon it; or by a fear of keeping close to the globe of the eye. There is no fear, especially for an anatomist, of cutting into the sclerotic. The tendon, before it is lost in the sclerotic, lies for some, or all, the distance along the surface of this membrane; so that to insert a hook beneath it, the point must be brought to bear at a point inferior to and behind the insertion; and then, being steadily pressed against the sclerotic with some little force, the point must be carried upwards and backwards and then a little forwards. In these operations for the division of tendons we must also recollect where and how wide is the insertion; and in this they vary a little. The opening in the conjunctiva should be made no larger than will be enough. The conjunctiva, when the tenotomy is completed by this method,

prevents the eye from being carried unrestrainedly in the opposite direction. The object is not merely to divide the tendon; but, according to the degree of distortion, the operator will separate, more or less, the tendon and muscle from its surroundings. In an extreme case, any minor tendinous insertions lying beneath the chief portion of the muscle concerned must be searched for and divided; while, in trifling cases, these, or at any rate the areolar tissue in connection with the tendon, should be undisturbed. It is not advisable, however, in extreme cases, that the operation should be made to resemble the old squint-operation, by dividing the conjunctiva over the insertion of the tendon. If this be done in internal strabismus, it leads to retraction of the caruncle and the plica semilunaris, and a staring look of the eye, although it be made to act in a parallel direction with the other. In extreme cases, the corresponding tendon of the opposite eye probably should be divided. The test of complete tenotomy in these cases is that, when the hook has been passed so that if any fibres were uncut they would be caught in it, the concavity of the instrument can be brought up to the convex edge of the cornea under the conjunctiva, and will remain there passively, without any dragging force.

As squint-operation is a painful one, at any rate as compared with most eye operations, it is usual to give an anæsthetic; but, during and after the inhalation of chloroform, the muscles of the eyes do not act together as they would without its having been used, and, at any rate, at such times the patient cannot be made to attend well to the surgeon's wishes. Children with or without chloroform will not give us this assistance, and they therefore at least should always have the anæsthetic.

The operation being over, and it being found that the tenotomy has been satisfactorily done, a piece of lint wetted with cold water, and a round hollow sponge dipped in the same, are at once tied tightly over the eye, with a strip of common bandage fastened behind the ear in a knot. In six hours the lint, sponge, and bandage may be left off (the fear of "black eye," or much ecchymosis, being past), the two eyes may be uncovered and brought into use together (for distant objects as much as possible), and the eyes only bathed with lukewarm water as often as the patient may desire it.

Tenotomy, as concerns the muscles of the eyes, is hardly ever done but for the cure of one or other of the kinds of squint actually existing. It is, however, desirable to divide the external rectus tendon in some cases of muscular asthenopia (insufficiency of the internal rectus muscles), as well as of external strabismus, and several of the tendons (sometimes in the same eye of the same patient) have been divided in cases of oscillating globes.

OPERATIONS ON THE EXTERIOR OF THE GLOBE.

Pterygium.—This is not a common disease in England. The cases we have seen have been in adult men, sailors, perhaps foreigners.

Pterygium is to be got rid of, because it will always steadily advance up to the centre of the cornea, and so, to some extent, interfere with vision; and very much too, if, as is not uncommon in these cases, more than one pterygium should form in the same eye, and, advancing from different directions in the circumference, meet in the centre; or if, as is not common, a pterygium should advance from below upwards. The growth is also to be removed, because it is a conspicuous deformity, easily remediable, so that at least only an irregular whitish scar is left in its place. A pterygium should be removed in any stage of its growth. At first, it is but little redder than the surrounding conjunctiva, and hardly at all raised above the conjunctival surface. It has then been called a "membranous pterygium." Afterwards it becomes very much more vascular and raised above the surface—"fleshy pterygium." In either case an operation is called for. No other treatment is of any use.

Pterygium has been removed by dissecting up the growth from apex to base, transplanting the apex of the flap thus formed into an incision made along the lower part of the ocular conjunctiva beneath the lower lid, and fixing it with sutures in this position. I do not remember that in any of the cases in which I operated in this way the disease returned; but excision of the whole growth more effectually removes the deformity than merely transplanting it; and total abscission is the commonly adopted practice nowadays. Nevertheless, even when carefully removed, pterygium is apt to return; and hence it is important in operating to remove the whole thickness of it, down to the sclerotic and cornea.

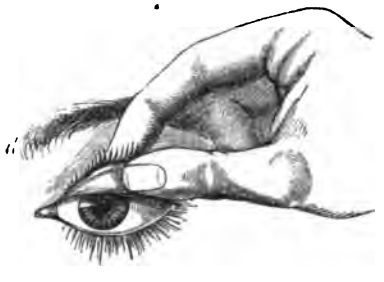
[After the removal of pterygium, the seat of its attachment to the sclerotic may advantageously be touched every few days with a crystal of sulphate of copper, with a view of checking the tendency to reproduction.—A.]

Operation.—An incision is made with a scalpel through the conjunctiva, along the borders of the growth, whilst put on the stretch by the eye being drawn with forceps in the opposite direction, if necessary by an assistant, and then with a pair of forceps, with rather long sharp teeth, the whole width of the pterygium is taken up, between the two lines of incision in the conjunctiva, at about the middle of its length, and raised sufficiently to allow the scalpel to be thrust beneath it with the edge towards the cornea. The growth being well raised from the surface of the globe, and the traction made in the direction opposite to the plane of the pterygium being relaxed, the scalpel is carried onwards, close to the surface of the cornea, up to the centre or as far forwards as the growth extends. The whole is shaved off at once; the flap is then seized and raised, and dissected off the surface of the sclerotic, and finally removed altogether as far back as it seems to extend at its base, near the junction of the ocular and palpebral conjunctivæ. If any small portions of the pterygium have been left, they should be seized and shaved off the surface of the cornea or sclerotic. The growth should be removed quite up to its margins and to its apex, as far forwards on the cornea as it extends. It may everywhere be raised with forceps from the firm structures, cornea and sclerotic, beneath. If a fine shaving of sclerotic or cornea be taken off, it is not of the serious importance that has been suggested; but of course it should not be done. All soft parts, where the pterygium is situated, should be dissected off the sclerotic and cornea; and if the knife be held flat to the surface of the globe of the eye, there is no fear that an incision will be made actually into the globe.

After the operation no special treatment is required; but, by using warm water to bathe the eye, great cleanliness is maintained; and, if the movements of the eyes cause any pain in the eye operated on, they may be tied up, and so kept at perfect rest for awhile.

Removal of Foreign Bodies External to the Eye.—A foreign body, such as dust or particles of coke, superficially sticking in the eye, is generally to be found imbedded in the cornea. It is probably soon dislodged from the sclerotic conjunctiva, as it is loose and easily moved, and is washed away in the tears. The cornea is the most prominent part of the eye; and if a foreign body should hit the sclerotic conjunctiva, it is probably somewhat obliquely, and so it may glance off at once and not remain there. It is often very difficult to see the very small foreign bodies which lodge in or upon the cornea, especially if the iris be dark-colored, as they are also generally. In order to detect the presence of a foreign body, the surgeon must open widely the patient's eye in a good light and bid him look in various directions or on all sides, successively; when, if the iris be light-colored, the foreign body is probably soon detected as a dark speck, and may be removed forthwith. If it be not thus detected, the lower lid must be pulled down with a finger placed on the skin of the lid, and the patient desired to look very much upwards, so as to expose completely the palpebral and ocular conjunctival surface of the lower part of the eye. It is, however, more probable that, if the foreign body be under either eyelid, it is the upper one. In this case the surgeon, standing before the patient, places the end of his forefinger sideways on the lid near its outer edge, without involving any folds of loose skin; and, pressing a little on the eye, makes the lid slide downwards, as far as possible, over the lower lid. The lid (not the lashes) is then seized firmly by the end of the thumb applied sideways; and the end of the forefinger is turned downwards, while the lid is held firmly by the thumb and finger. The lid is thus everted (Fig. 394). This is a better plan than using a probe, or a pen laid horizontally on the lid, and then pulling the lid by the lashes over the barrier so as to evert it. The fingers are always available, and the patient is not so much afraid of them as of any instrument. The little operation cannot, however, be done the first time it is attempted. The patient may

Fig. 394.



Eversion of upper lid for detection of foreign bodies.

move back his head just as the turn is to be completed (therefore the hea
patient must be steadied by being placed against the wall, or the back of his
by the other hand behind it); or the lid is not secured between the finger an
before the eversion is attempted; or the lashes only and not the lid are held
fears to press the forefinger sufficiently into the eye to effect the eversion. I
much more difficult if the patient be fat, the eye deeply set, and the orbicularis
or the lid thickened and contracted—inclined to be inverted by old results of
mia. The upper lid being everted, it is held so and pushed upwards as r
possible with the thumb against its edge; and, the patient being desired to lo
much down, we expose nearly the whole of the upper palpebral and ocular c
tivæ. If the foreign body be not now seen, it is well to pass the tip of the fo
lightly over the everted palpebral conjunctiva, as, in this way, the foreign bo
perhaps, if transparent, be felt; or we may pass the spoon-end of a commor
quite up to the sulcus, if it cannot be seen, and along between the upper pa
and ocular conjunctivæ, to catch the foreign body if it should be there
placing the patient in a strong light and making him throw his head far back
it is possible by drawing the upper eyelid directly forwards to see beneath it
up to the sulcus. I have in this manner sometimes detected a foreign body
could not be found in any other way.—A.] If it be not now found we may
examine the cornea, for it is here that nearly all foreign bodies in the eye are
and the oblique illumination with the ophthalmoscope, using a second conve
as a magnifier, may be serviceable in this examination. Not unfrequently a
foreign body, such as a small button, or husk of corn, purposely or accide
introduced, under the upper lid, has passed beyond the upper edge of the car
and so is retained for months or years, until the persistent slight irritation le
its detection and removal. Therefore, in doubtful cases, as above recomme
the spoon-end of a probe should be used.

To avoid error in diagnosis, it is always well to inquire if the patient reme
the time at which the foreign body entered the eye, when he has the sensation
existing foreign body, for there are many irregularities of the surface of the p
bral conjunctiva, which, in its movements, give the sensation as of a foreign
when there is none. Conjunctivitis especially is a cause; and if there be no
cause, and the patient recollect no particular time at which he first felt the fo
body, and "something got into his eye," we must look for some little tumor
somewhat inverted eyelash or other persistent cause.

A foreign body in the cornea is best removed with the end of a little instru
which is like a piece of wire flattened at the end, and with a round edge, but
sharpened, like a "spud." A piece of wire, beaten out at the end, is the instru
made for themselves, and used by some one of their number, by the workmen in
of the large factories. With this, the lids and the eye itself being held open
fixed with the fingers, the foreign body is turned out of the hollow in which
imbedded. Sometimes, if it be very deep in the cornea, a sharp-pointed instru
may be used.

[An ordinary cataract needle will answer for this purpose as well as anyth
else.—A.]

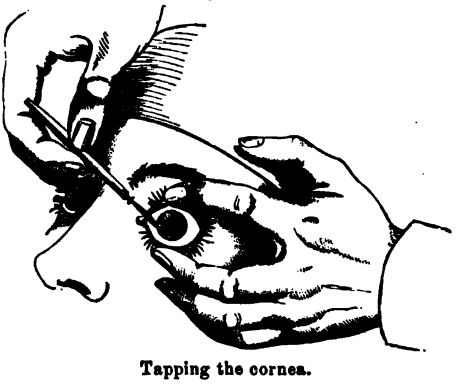
There is a class of cases by no means common, which may be considered toge
with foreign bodies in or upon the cornea, for the offending substance is quite
perficial to the cornea and keeps up irritation. But if accidentally it has, and
suddenly, entered the eye, it appears as a perfectly opaque, dense, whitish opa
on the front of the cornea, unlike leucoma in its *perfectly definite* outline, and
being very superficial and *dead-white* in appearance. There is also some inject
of the eye, which there is not generally in cases of circumscribed leucoma—the de
corneal opacity left long after the inflammation before it. The foreign body is
posited in some hollow of the cornea, an excoriation, abrasion, or ulcer, proba
after using some lotion of acetate of lead, which is too often applied by patients
all eye-inflammations indiscriminately. It must be picked out of the little hollo
like any other foreign body; and if it be beneath the epithelium, this must be scrap
off, and then the deposit will be found immediately beneath it; and in these cas
with some difficulty, little by little, in broken flakes or fragments, it can be remov
with the point of a knife, or with the edge of it held flat, it may be shaved off.
should be, at all events, altogether removed; for if it should be succeeded by a der
leucoma, the latter is of no importance beyond the fact of the opacity of the corne

whereas the former is somewhat equivalent to a foreign body also. But it will not probably be followed by a leucoma; the cornea will become and remain tolerably or quite clear when this superficial opacity is removed from its surface. A little olive oil is dropped upon the cornea, and the eye bandaged with belladonna lotion or fomentation, until the wound has healed and the epithelium is restored.

Tapping the Cornea, or Paracentesis Corneæ.—This little operation does no harm in itself, and it often does much good, in cases generally only medically treated, locally and generally. When there is pus between the layers of the cornea (*onyx*) or in the anterior chamber (*hypopyon*), if there be much pain, or in *painful* ulcer of the cornea, it often acts like a charm; the aqueous and pus are evacuated, the pain disappears, and the chronic ulceration of the cornea begins to heal kindly. The operation should be adopted in a greater number of cases; but it must be done properly without wounding the lens or iris, or doing anything but just to make a small clean puncture obliquely into the aqueous chamber and so letting the fluid contents leak away quietly and not very rapidly. In onyx and hypopyon, the tapping, to be efficacious very often requires to be repeated at short intervals; and if it fail, as it will probably, if it do not from the first seem to have been beneficial, after having been once or twice repeated, iridectomy, must be done, and will probably succeed. Iridectomy is often performed at once in these diseases; but, in most of the less confirmed cases, the minor operation of tapping is a ready cure.

Operation.—A spring (stop) speculum to keep open the lids, and a fine ended and two-toothed forceps to steady the eye and hold it down, may be and are generally employed. But, unless pressure on the globe would endanger the good result, they are unnecessary, and are liable to alarm the patient. In performing the operation, the upper lid should be raised, and the end of the forefinger of the left hand laid horizontally and rather flat upon the edge of the lid and the globe above the cornea, taking care here, as in other eye-operations, not to touch the eye with the nail. The *lower* lid is similarly depressed and held down with the middle finger of the same hand. The two fingers are separated as widely as necessary, and such pressure is exerted upon the globe backwards as will allow of no opportunity of closing the lids and of the orbicularis regaining its power of action (Fig. 395). The front of the globe is now very prominent, and the eye is at least as much under control as if it were held with forceps. With an ordinary broad needle, flat forwards, held in the right hand, the puncture is made in the cornea near the margin, the point being soon directed obliquely downwards and across the anterior chamber as if about to make a counter-puncture at one third of the circumference. As the eye tends to roll upwards, the needle, when directed downwards, cannot wound the lens. In this way the blade never passes the pupillary margin; its point is always in front of the iris, never of the lens (Fig. 395). As soon as the broadest part of the blade has entered the cornea, it is partly withdrawn, and, cutting downwards a little meanwhile, the point of the needle is again directed to the centre of the anterior chamber. As the opening is now a little larger than the blade, this can be rotated a little; and, when it is held in this way, the aqueous humor or the contents of the aqueous chambers will flow out beside it, more or less slowly, according to the amount of the rotation. As it is almost all evacuated, the pressure of the two fingers, keeping open and steadying the eye, must be a little remitted; probably no great effort at movement will be made by the patient, but, to prevent possibility of accidents, the broad needle, still held flat forwards, should now be brought altogether somewhat forwards, and may thus be used in some degree as a *point d'appui*. The operation done, the needle is quickly withdrawn, and, the fingers being removed, the eye closes. In this brief and simple operation, every precaution must be taken against wounding the lens and making a traumatic cataract. This accident may occur whether the eye be steadied by the finger or by speculum and forceps, either when the needle is introduced, or when the

Fig. 395.



Tapping the cornea.

last of the aqueous humor is let out. The operation is attended with little or no pain, even if anæsthesia be not employed; and, if the fingers and one instrument only (the broad needle) be used, the soft parts of the fingers give no pain, and the patient is but little alarmed.

OPERATIONS ON THE IRIS.

Artificial Pupil.—In this operation a piece of the iris is either removed altogether, *excised* (iridectomy); or, by simble *incision*, an opening is made in the iris-tissue. The term artificial pupil is applied as much to any operation by which the natural pupil is displaced and altered in shape and position, as to those by which an addition is made to the natural pupil, or those by which an altogether new opening is made in the iris itself.

There are many different directions in which an artificial pupil may be made; (1) central and downwards, or (2) down and inwards, or(3) down and outwards, or (4) inwards, or (5) outwards. The upper lid so much covers the upper part of the cornea and iris that it is a forlorn hope only when the operation is done any way upwards, as *direct* means of improving vision (see "Iridectomy for Glaucoma," p. 844).

Artificial pupil, *per se*, is called for in many very different cases.

1. In *partial opacity of the cornea*, with or without iris-adhesions, it is required to make a pupil opposite clear cornea.

2. In *total posterior synechia* (exclusion of the pupil), it is practised to re-establish communication between the anterior and posterior chambers, &c.

3. In *closed pupil* (occlusion), it is required to make a pupil opposite clear (uncovered) lens, &c.

4. In *central lamellar cataract*, this operation is performed to bring the pupil opposite clear (non-cataractous) lens.

Next to cataract operations, those on the iris essentially are those which the ophthalmic surgeon is most frequently called upon to perform. They make nearly one-fifth of all the operations done in 1867 at the Royal Ophthalmic Hospital in Moorfields. If an operation for artificial pupil be thought of in a case in which the natural pupil is quite obliterated, or where, in any case, even with atropine, an ophthalmoscopic examination of the fundus cannot be had, the surgeon must first carefully ascertain that the eye retains perception of light. But, in order that the operation may be likely to succeed, the patient should not only have a perception of light, but should be able, when the other eye is closely covered with the palm of the hand, to readily perceive the shadow of the hand of the surgeon when it is passed quickly before the light, between it and the eye of the patient. If there be a less degree of vision remaining, if the tension of the eyeball be plus or minus, or if there be intra-ocular pressure, or atrophy, there must have been some deep-seated disease, besides the iritic inflammation, the immediate cause of the obstructed pupil. After estimating the degree to which vision is impaired in the case of proposed artificial pupil operation, the surgeon must observe accurately what evidence of past disease he can see with his own eyes, and compare all this with the history of the case. If corneal opacity be the reason why an artificial pupil must be made, the operation must be deferred until, after some months at least, no improvement by progressive clearing has taken place, according to the history of the case, or by the surgeon's observation, no redness of the sclerotic has appeared around the cornea, and no former operation of the same kind has been attempted. A lad was admitted at University College Hospital for the operation of artificial pupil. He had had keratitis of both eyes some years before. He had been treated as an out-patient for a long time, with cod-liver oil and syrup of iodide of iron, &c. He was anæmic and, apparently, lived badly. When taken into the hospital he had full diet, and he sat, almost blind, by the fire with the other patients. Very soon he could see better, and in a short time the clear marginal part of the cornea was wider. When the operation was performed, a few weeks after his admission, it was remarkable how his corneæ were cleared, after they had been at a stand-still for months, if not for a year previously.

In any case of opacity of the cornea extending nearly to the margin, and allowing at no part any wider clear space for artificial pupil, the incision of the cornea must

be made in the sclerotico-corneal junction and very little obliquely, so as to enable the iris to be drawn out quite up to its outer circumference.

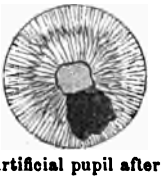
Artificial pupil, if one eye *only* be diseased, is *urgently* required if there be total posterior synechia or numerous adhesions, and should be done although the performance of the operation is not urgent, *if the patient inclined to it*, in any of the other cases, even if the unaffected eye were perfectly sound.

Incision.—This is an operation not much in use. It is advisable perhaps only when the lens is no longer present, or is useless by results of operation or injury, and the iris has prolapsed through the corneal wound; or when the pupil has been obliterated in consequence of iritis, the cornea remaining clear, and when, there being no communication between the anterior and posterior aqueous chambers, the iris-fibres bulge forwards all round wherever they are not too tightly stretched. When they thus bulge, though a transparant lens may be supposed to exist behind the iris, it may perhaps be *safe* to incise the tense iris-fibres; but, in such a case, probably an iridectomy would be a better operation. It is probable, indeed, that mere incision for the formation of an artificial pupil, should be confined to those cases in which the operation for cataract has been followed by inflammation and

Fig. 396.

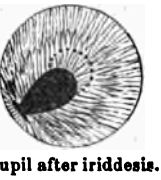
Incision of iris.

Fig. 397.



Artificial pupil after iridectomy.

Fig. 398.



Pupil after iriddesis.

Fig. 399.

Iridectomy for glaucoma.

closed pupil, with stretching of the iris-fibres. If, in such a case, the surgeon anticipate inflammation to follow another operation, one cut with a broad needle may be rapidly made. In such cases, too, the iris may be fearlessly incised; there is no transparent lens or no lens to be wounded. The vitreous humor probably protrudes through the opening in the iris; and, if no fresh inflammation be set up, a good pupil may be made, and may remain (Fig. 396). Just after the operation, when the pupil is first made, it will appear, of course, to be good, because the protruding vitreous body then makes it appear very black and clear.

Operation.—The eye being well steadied with wire speculum and forceps, or with the fingers, a broad needle, with a cutting edge not confined to the part near the point, is thrust through the cornea and then through the iris at one extremity of the intended incision, and, as it is withdrawn, it is made further to divide the iris-fibres to the other extremity of the aperture that is to be made.

Iriddesis.—Before this operation was invented by Critchett, there was an operation for artificial pupil, which consisted in effecting a prolapse of the iris by the cornea, and thus it was hoped an anterior synechia would result; but, by tying the iris externally, it is secured, and cannot return, even partially, within the anterior chamber. The operation is well adapted for cases in which the pupil is free, or very little adherent, and that not at the part at which it is desired to make the artificial pupil. It is *not* suitable for cases in which the pupil is required to be quite close to the corneal margin, or when a very large one is desired. For, by this operation, the pupil is made pointed and narrow at the part nearest to the corneal margin, not quite reaching it; and if it seem too small, a second iriddesis is a clumsy expedient, and makes, perhaps, an uglier pupil than an irregular-margined iridectomy. If the pupil be much adherent, of course it cannot be drawn aside and tied there; nor if the iris has been long diseased, and so has become thin and rotten, can it be done, for the iris-hook or scissors will tear through it, in the attempt to make the artificial prolapse and permanently to displace and draw aside the pupil.

Iriddesis makes a regularly outlined pupil, of moderate size, largest towards the centre of the cornea (Fig. 398): it causes no bleeding into the anterior chamber and its subsequent complications. The iris may be larger or smaller, but not very large; and, as it is made, so it remains definitely.

The *operation* is done thus. The eye being exposed, and held with speculum and forceps, a broad needle is passed through the cornea at that part of the margin

towards which it is desired to displace the pupil. An assistant then places a little loop of very fine black silk over the opening on the wet surface of the conjunctiva. To draw out as much of the iris as is required, either an ordinary silver iris-hook is used, or, if it be desired not to include the whole breadth of the iris to be prolapsed, and the pupillary margin is to be left free, a canula-forceps is used to seize the iris midway between its greater and lesser circumferences. The part of the iris which is to be secured being now drawn out by the corneal aperture, the assistant holding in each hand a forceps with broad ends, like those used for pulling out eyelashes, seizes the ends of the ligature, and, when desired by the surgeon, tightens the loop and leaves it. This he does whilst depressing a little the ends of the two forceps, so as to tie the knot quite close to the cornea; and he is careful not to pull the ligature more one way than the other, lest the iris be displaced. The iris, being very delicate, offers no perceptible resistance, and is very easily cut through. The ends of the loop are then cut off close to the cornea, the eye closed, and both eyes are bandaged. If the knot have been sufficiently tightened, the portion of iris so strangulated and the little loop of silk will drop off in a few days; and the iris, meanwhile, has formed an adhesion within in front.

It is always desirable to need as few instruments as possible, and to avoid the introduction of any instrument within the anterior chamber. In iriddesis, when there are no synechiæ, the surgeon may often do without either the iris-hook or canula-forceps, by almost withdrawing the broad needle, and intermittingly pressing back the posterior lip of the corneal wound so as to evacuate in jets the aqueous humor. Each time, a portion of the iris is prolapsed, and, when a sufficient quantity has escaped, it is seized as it lies outside the eye with iris-forceps, and the silk loop, which has been previously laid over it, is tightened. In this, and some other delicate operations that cannot be done quickly, and in which it is desirable that the eye should be perfectly still, a forceps with two ends to each blade, and an U-shaped space between them, five-eighths of an inch apart, may be used to hold the conjunctiva and subconjunctival tissues on each side of the cornea, and thus render the globe perfectly fixed and immovable except at the will of the surgeon (see *Ophthalmic Hospital Reports*, iv. 100).

Iriddesis is suitable for cataract of that "congenital" form (lamellar and nuclear) in which some layers, or some part of them, are definitely opaque, if centrally, with a clear marginal part. This form of cataract does not progress; and if atropine show a good margin of clear lens, generally behind the iris, we may make there an artificial pupil by displacement and ligature, and let the patient have the use of the natural lens rather than substitute a glass.

There is a class of somewhat rare cases, in which a *double* iriddesis is to be done for the improvement of vision. This is in "conical cornea." The iris is tied at the upper and again at the lower part, to make the pupil of a slit shape vertically. This imitates the opening in the diaphragm that used to be employed for these cases, to exclude the irregular refraction of the sides of the conical cornea. But the double iriddesis seems to do more good in another way; for, after it, the progress of the disease itself seems to be retarded or arrested: there may even be improvement (by lessening of the conicity). For this reason it should be done in these cases, though the slit-shaped pupil made by it is very wide, and more theoretically than practically an advantage. The slit being vertical, the upper and even the lower lid a little will cover the extremities or marginal parts beneath them.

Excision: Iridectomy.—This operation is advisable when a considerable opacity of the cornea leaves only a very narrow marginal part clear: when iritis has caused total posterior synechia (Fig. 397), or very considerable adhesions, which cannot be detached by the use of belladonna, or by operation: when perforating ulcer or other cause has ended in complete or almost complete adhesion of the pupillary iris to the cornea. When the marginal part of the cornea left clear is not narrow, or when, though there be little or no posterior synechia, an operation is required, or when anterior synechia involves less than half the pupillary circumference, iriddesis is probably the best operation.

Operation.—An anæsthetic is first given, and the eye is kept open and steadied in the usual manner with speculum and forceps. An opening of at least one-eighth of the circumference is made in the corneal margin with an extraction (Sichel's) knife. The forceps to hold the eye is handed to an assistant; and the iris-forceps,

closed and held in the left hand, is introduced to the anterior chamber. A sufficient quantity of the iris is seized and drawn out; and with the iris scissors laid flat on the surface, it is snipped off close to the cornea. The operation, with extra precautions at the time and subsequently, is described below (see "Iridectomy for Glaucoma").

An artificial pupil should not be very small, as it will more probably become closed by subsequent inflammation, or, if not closed, contracted till it is much too small. The iris must be seized with forceps: a hook may tear through rotten or firmly adherent iris, or will draw out too little. No blood should be allowed to remain in the anterior chamber, if it can be prevented. No clot should certainly be left between the edges of the wound in the cornea. And, if the iris, close to the part where it has been cut off, still hang in either angle of the corneal wound, it must be returned with the little spatula made for this purpose, or with the end of the curette.

Besides the operation for glaucoma, for artificial pupil, and for recurrent iritis, with adhesions, in which iridectomy is called for, there are many other cases in which iridectomy is now adopted. In some of them, as, for instance, in acute ulceration or hypopyon, with pain, simple paracentesis corneæ is probably often sufficient; or, at least, if we doubt the necessity for iridectomizing, we can give it a trial meanwhile.

Iridectomy for Glaucoma.—Although the common operation for artificial pupil, to which I have referred, or for recurrent iritis, may be, and is sometimes quite correctly, called iridectomy, as it used to be before the cure of glaucoma was invented, yet the operation and all about it is widely different from that for glaucoma, as may be seen briefly in the following comparison of the two iridectomies:—

Iridectomy to cure Glaucoma.	*Iridectomy for Artificial Pupil.*
There is no permanent opacity of cornea, or any obstruction of the pupil, leading to the operation.	The operation is done for opacity of the cornea, or obstruction of the pupil, or both.
The cornea and lens may be becoming altogether hazy at the time.	Both cornea and lens clear, at least at some part: at this the operation is done.
The globe is hard to the touch.	The globe may be soft, or hard, or normal.
The fundus would be well seen but for turbidity of the aqueous and vitreous humors probably, or haziness of the cornea and lens.	There is opacity or obstruction preventing examination with the ophthalmoscope, quite irrespective of any turbidity of the humours, or haziness of the other media.
The operation is best done during inflammation. (When there is pain, &c.—in the acute cases.)	The operation is only allowable when no inflammation exists.
Operation cannot be deferred.	Operation may be put off without harm.
The excision is best made upwards, where it is covered by the upper lid.	The excision should be made any way but upwards: where most convenient, at any exposed part.
The piece of iris should be taken specially from the greater circumference.	The piece of iris should be probably taken from the pupillary margin.
The piece of iris excised should be large.	It should be small, or smaller, at any rate, than that in iridectomy for glaucoma.
The good result of the operation is immediate.	The good result appears after a while.
The pupil is never afterwards blocked up.	Not unfrequently resultless by secondary iritis and occlusion of the pupil.

We see, therefore, in the first place, that in glaucoma the portion of iris to be removed must be taken from its whole width, quite up to its greater circumference (Fig. 399), so that the preliminary opening made into the anterior chamber must be in the sclero-corneal junction, or in the margin of the sclerotic itself; not in the cornea, as it should be generally in the formation of artificial pupil excision. For glaucoma, the piece of iris excised must be larger than is usual for an artificial pupil; and, that the gap made when the iris is removed may be hidden, it should be beneath the upper lid, just where an operation for artificial pupil would be out of the question. The chief steps of the operation are the same as those described already for operation of artificial pupil. But, chloroform having been given, if desired, the wire-speculum and forceps being used, to keep open the lids and to steady the eye, an opening extending one-fourth of the circumference must be made in the sclerotico-corneal junction, or even in the margin of the sclerotic, at the upper part. About one-fifth of the whole iris is removed in the operation. For

this purpose, a lance-shaped knife is generally thrust into and across the anterior chamber, and the incision is extended, if necessary, as the knife is being removed; but an ordinary (Sichel's) extraction-knife is much preferable. It cuts better, requiring less thrusting force, and with it the inner and outer openings of the wound in the cornea may be made of the same size, and less obliquely through the coats of the cornea, nearer, that is to say, to the greater circumference of the iris, which we want to reach; and the point of the cutting instrument may be kept quite away from the front surface of the lens, instead of being, as when the lance-knife is used, necessarily carried straight across it. In glaucoma, the anterior chamber is very shallow. The point of the knife, which may be held in the right hand for either eye, if the operator be not ambidextrous, is introduced in the sclero-corneal junction, at the right extremity of the incision to be made, and carried towards the centre of the anterior chamber; and, when it has well entered this chamber, the cutting edge is directed upwards, and, being thrust onwards steadily, with a firm hand, so as not too quickly to evacuate the aqueous humor, is made to cut, by slight movements up and down, vertically (not by making a counter puncture, as some recommend) as far along the extreme margin of the cornea or sclerotic as the length of the incision is to be made, perhaps one-sixth of the circumference. The knife, as it is withdrawn, is then brought once more with its point directed towards the centre of the chamber, so as to make a similar square extremity of the incision to the end at which it was begun. Then, as in the excision-operation, for artificial pupil, the fine curved iris-forceps is introduced, and the toothed points opened in the anterior chamber (unless the iris have prolapsed, with the flow of aqueous humor, when the corneal wound was completed) widely enough to seize a rather large portion of the iris. This is then drawn fully out, and is first cut through with the iris-scissors vertically on the right side; then the blades of the scissors being held flat on the surface of the globe, it is divided along its ciliary attachment, close to the opening into the anterior chamber, and, lastly, it is separated altogether by another vertical cut. The operation is then complete. If much bleeding into the anterior chamber occur, the blood must be, if possible, coaxed out in one way or another, and before it has formed a clot. The point of the curette between the lips of the wound, or on its posterior lip, may do this; or the blood may be pressed out with the convex back surface of the same instrument, by passing it, wet with tears so as not to abrade the epithelium, from below upwards, over the front surface of the cornea; or, by gently pressing back the wire-speculum upon the eye, it may be squeezed out. If there be bleeding, however, some blood will probably be left, and cannot be removed. The eye is tied up with some lint, wet or dry, over it, and a bandage is applied over both eyes.

Diagnosis of glaucoma.—In the diagnosis of a case of glaucoma, much stress must not be laid on the meaning of the word—the *sea-green* color in question is often not at all seen in the reflected light from behind the pupil. The chief diagnostic signs are these: 1. *Tension* in excess—varying from the least degree, T. 1, to a stony hardness, T. 3. It is appreciated by the two forefingers, used much as in trying to discover the existence of deep-seated pus; or the amount of tension may be appreciated by the eye, as well as by the touch, by placing the point of the forefinger on the ciliary margin of the patient's lower lid, and indenting the globe, as he looks up. 2. *Pain* in and around the eye, which is often intolerable, generally intermittent. Rarely does a case of painless (non-inflammatory) glaucoma occur. 3. *Halos* are seen around the light. 4. *Presbyopic* symptoms are present. 5. There is *narrowing of the field* of vision. 6. There are *obscurations*. 7. The *appearance of the eye* externally: *a*. Large tortuous vessels are seen to course over the sclerotic, and dip into it in the ciliary region. *b*. The anterior chamber is shallow, the lens, and the iris with it, being, by pressure from behind, thrust forwards in approximation to the back surface of the cornea. *c*. The pupil is large and inactive. *d*. The cornea has more or less lost sensibility, and reflects light from its surface imperfectly. *e*. The lens is perhaps cloudy (not cataractous, not opaque after iridectomy). 8. *Ophthalmoscopic appearances*. When the fundus can be seen (and it very often can be), though the aqueous and vitreous humors be somewhat obscured, even when the cornea looks steamy and the lens cloudy, the excavation, more or less, of the *entire surface* of the optic nerve entrance, and tortuosity and congestion and pulsation of the retinal veins (and arteries), which are displaced and compressed against the white margin of the "cup," and some little ecchymoses therefrom perhaps, are

the marked features. These signs are all due to increased intra-ocular pressure, in consequence of the contents of the globe being more than is normal.

Glaucomatous is a term applied to symptoms of increased intra-ocular pressure (tension) in other diseased states of the eye. As it is specially important to recognize glaucoma in its first stages, we must not look for the corneal and lenticular changes, or much "cupping" of the optic nerve in all cases of the disease, or the operation will have been deferred long after it should have been done. Glaucoma is a disease of elderly or of old people of impaired health. The earliest symptoms are, to the patient, perhaps, intermittent obscurations, halos, and more or less wandering pain; and, to the surgeon, increased tension, some congestion, dilated pupil, shallow anterior chamber, and, ophthalmoscopically, some excavation of the optic nerve-entrance and venous pulsation. In the case of an eye blind by old neglected glaucoma, iridectomy will perhaps relieve pain; but probably it should be extirpated.

The benefits of iridectomy, properly performed, and sufficiently early in glaucoma, are patent; and it must be done, when the opportunity offers, even when the time most favorable for its performance is gone by, and even in the chronic cases, in which the results are always least advantageous. Without operation, glaucoma certainly ends in total blindness. It is probably, in the first place, choroiditis, and effusion in the vitreous space. It goes on by producing such structural changes in all the tissues of the globe, that total disorganization is the result.

[Repeated tapping of the cornea, and division of the ciliary muscle or ligament (*cylicotomy*) have been proposed as substitutes for iridectomy in the treatment of glaucoma. The second operation referred to, which is generally known as Hancock's, has been favorably reported of by several surgeons, and would certainly appear *a priori* to promise as good results as iridectomy; the balance of testimony is however on the side of the latter operation, which, in the present state of science, seems to be the best treatment for acute glaucoma.—A.]

CATARACT.

Until within a very few years, it was considered an easy matter to determine, in any case of cataract, what operation should and would be done. One was a case for extraction (by a large flap, as it is now called), another as certainly would be removed by needle operation, and a third by linear extraction, as it was called. Now every ophthalmic surgeon is in search of some improved method which shall diminish the number of his unfavorable results; and everything is changed for the better, or it may be for the worse. It is rather a bold thing, as far as the profession is concerned, to do an extraction as it is used to be done, making a semicircular section of the cornea, &c. This state of uncertainty makes it also very much more difficult to say what operation is meant by name, or to venture to recommend any particular operation in any case.

Diagnosis.—Cataract is more common in old or elderly persons, and in them it is of the kind called hard cataract. In younger persons, and especially in children, cataracts are comparatively soft. The senile cataracts are generally striated; the streaks being very evident in the commencement of the disease, and less seen as the whole lens becomes opaque. They are generally a little amber-colored, especially in the nucleus. The others are comparatively little or very indistinctly striated, and of a milky color. Striæ in the lens are almost invariably found to radiate from an opaque central spot to the circumference, or to project towards the centre from various points of the circumference of the lens. In fact the striæ, according to the direction of the lens-fibres, always diverge from or converge to the centre of the lens. In any case, unless the whole lens be cataractous, opaque streaks, such as those described, may be seen. In hard cataracts the cortical parts are always comparatively soft, sometimes very soft, with a hard nucleus. In rare cases, an indefinite central haze, without any pattern, indicates the beginning of cataract. But there are not unfrequent cases of haziness of the lens, as a senile change, or from intra-ocular pressure (see "Glaucoma"), which must not be called cataract, for they are sometimes found together with good vision. The haziness may disappear, or it may never go on to a complete or real opacity of the lens. This is an important distinction; and no doubtful case must be said to be one of cataract, unless, by examination with the ophthalmoscope, by the direct or oblique methods of illumination,

striæ be seen, or such a degree of central haze as to obscure the image of the fundus, when, by direct illumination of the ophthalmoscope, a *bright* light is thrown into the eye. If any less definite rule be adopted, it will lead to innumerable misunderstandings and false anticipations. When an eye, in which striæ exist in the lens, the rest of it remaining transparent, is examined by direct illumination, the pupil, of course, being first of all dilated with atropine, the mirror of the ophthalmoscope only being required, the several streaks appear black, in front of the light behind them of the brightly lit-up fundus of the eye; whereas, when the same lens is examined with a side light, and the ophthalmoscope lens only used (oblique illumination), the striæ appear whitish against the dark pupil; for the light is reflected from the front surface of opaque parts of the still partly transparent lens. Thus, by these two methods, we have, in doubtful cases, a means of checking our diagnosis. The cases of *hazy* central commencing opacity of the lens, which are to be called cataract, have been defined already. Of course, in case of a patternless non-striated opacity of the lens, far advanced, the *whole* lens so evenly opaque that no part of it allows an inspection of the fundus, there need be no question of the existence of cataract. That the opacity is not in the cornea, or in any part behind the lens, is found at once by observing the apparent change in the relative position of the parts, when, in a good light, the observer moves his head from side to side, whilst the patient keeps his eyes fixed on some other object. That it is no opacity in the pupil, is known by the use of atropine, which must of course always be used beforehand for the diagnosis of cataract, in doubtful cases, and which will not regularly dilate the pupil if this be not free. Of course there may be obstructed pupil and cataract behind it; but then we cannot certainly make out the latter. Or, if there have been iritic effusion and adhesions now freed, there will be evidence of old iritis. Or, if the opacity be in the vitreous space, it will be evidently so far behind the level of the pupil as to show its situation by oblique illumination.

Besides the idiopathic, there may be, at any time of life, *traumatic cataract*. Any wound of the lens, unless it be a slight clean cut, and not very deep, is followed by opacity of the whole lens. The surgical treatment of senile or hard cataract, of soft cataract, and of traumatic cases, is very unlike in many respects. The latter only are of urgent need as to any operation to be done. Wounds of the eye and lens, as of other parts, when they have occurred, are generally found to have been in young persons, or at least not in old people. Hence traumatic cataracts generally resemble the more the soft cataracts, so called, in being soft and whitish. In older persons, the opacity following a wound of the lens will be found to have a hard nucleus, if it be not altogether hard. The wounded lens swells up considerably, and in young people very rapidly, by the admission of the aqueous humor; and herein lies the urgency of the call for surgical interference. The swelling of the whole lens and the gaping wound, by which an irregular protrusion of swollen lens-matter takes place, if the lens be not wholly swollen, press upon and rub against the iris and ciliary processes in their movements, and set up iritis and deeper-seated inflammation, which will not, of course, subside, until the exciting cause is removed. It is in traumatic cases, accidental or surgical, and in these only, of cataract, that no delay is permitted.

Cataracts affecting, for the most part, only the cortical fibres of the lens, have been called *capsular*. *Anterior capsular cataract* shows of course the shape of the convex surface as it is seen in front and just behind the pupil. In *posterior capsular cataract*, there commencing, the striæ appear rather yellow, not white, because they are seen through the thickness of a lens which, by age, is yellowish, as are all old lenses, cataractous or not; and some of them, without being cataractous, have yet a slight haze in them, nevertheless not a commencement of cataract. Capsular cataracts are only commencing cataracts, where the opacity first appears in the cortical layers. If cataract begin as a stellate central patch in the lens, of course vision is at once much interfered with, and is probably benefited by the use of atropine from time to time; whereas, in both these respects the reverse is true, if the striæ project only towards the centre from the circumference of the lens. In any case, even the most complete, of cataract, it must be remembered that, though the fundus of the eye cannot be seen by the surgeon, the patient can always, if the case be uncomplicated, see a bright light very well, the other eye being covered, and can at once equally tell the absence of it when the hand is before it. The "field of vision," also, within which the patient can see the light, is not reduced in size. The patient

has not the hopeless look of blindness of an amaurotic patient; he seems to look for the light and to enjoy even such vision, of light only, as he has left to him. So it is also in any case of non-nervous blindness, in leucoma, &c. Also, in the prognosis of a case of cataract to be operated on, one expects to find a pupil ready to dilate well or to contract, a good-sized anterior chamber—in fact, an apparently healthy eye but for the cataract; no increase or decrease of tension of the globe; no history of former pain, and so on. Arcus senilis is no reasonable objection to operation.

Extraction by Flap-Operation.—The old operation of extraction by a semicircular flap is thus done. The patient is lying on his back on a high couch with his feet to the window; the surgeon standing behind him having cautioned the patient against any irregular movement on his part, puts his forefinger against the lower edge of the patient's upper lid, using his left hand for the right eye of the patient, and *vice versâ*, raises it, and holds it securely against the upper margin of the orbit. The middle finger is put on the surface of the globe, on the nasal side, to keep it from rolling inwards. An assistant has charge of the lower lid, which he depresses and holds securely against the edge of the orbit without any pressure on the globe itself. The surgeon, with the extraction-knife, held like a pen in his other hand, again cautions the patient, tells him to look towards his feet, and, resting the hand with the fourth finger on his cheek, enters the point of the triangular knife at the outer side of the cornea, near its margin; then, not allowing the eye to be rolled in, he thrusts the knife rather quickly across the anterior chamber in front of the iris, and penetrates, from within, the cornea at the inner side, making the counter puncture just opposite to and symmetrical with the first; so that the upper half of the cornea is in front of the knife or before its cutting edge. The knife is now only thrust onwards as far as it can be, until the flap is completed; but this, very probably, cannot be done but in drawing the knife back again a little, or by little to-and-fro movements. Until the section is nearly completed, and the knife has passed in front of the whole iris, it must not be at all retracted; or the aqueous humor is allowed to escape, and the iris falls in front of the cutting edge. The lids are now freed, and the patient told to keep them gently shut. After a short rest, the lids are held open, but they need not be again so firmly fixed as before; the patient is then told again to look down, the convex back of the pricker, held horizontally, is inserted between the edges of the corneal wound, carried down to the pupillary area, and turned with its point against the capsule of the lens. Then, by a few light scratches, this is freely lacerated and the instrument withdrawn, with its back turned upwards, so that its point may not be caught in the iris or cornea. The eye is again closed for a minute, and when again opened, it is by the operator only, who raises the upper lid, as before, but without much pressure against the edge of the orbit, and then he places the convex back of the curette horizontally on the skin of the lower lid near its margin. With this he makes intermittent light pressure on the globe just below the ciliary region, and synchronous counter-pressure with the point of the forefinger, which is holding the upper lid at its margin against the ciliary region just above the corneal wound. This requires much tact and attention. If the globe be compressed too far back, the lens will escape violently, and not improbably with some of the vitreous humor. If it be compressed too far in front, the lens may be dislocated, but not out of the eye; it may fall back into the vitreous space and be lost. If all go well, the upper edge of the lens is seen to come forwards through the pupil which is extended, and then rides over it and presents itself in the corneal wound. The pressure should be kept up or increased until little by little the lens has advanced so far that at least more than half is without the wound. Then, the pressure exerted being little and equal, the lens, if it remain in the wound, may be rolled sideways out of the wound with the tip of the middle finger of the hand which steadies the upper lid. This is better than increasing the pressure up to the final evacuation of the lens, as vitreous humor may follow it, and better than omitting altogether the pressure exerted, or much of the softer cortical parts of the lens are likely to be detached and left in the lips of the wound and in the anterior chamber. Any such are in the next place removed with the curette, if it can be done without much interference. If the iris be now inclined to prolapse, it may be pressed gently back with the small spatula, made for the purpose, held horizontally. The instruments, knife, pricker, &c., are all held horizontally, so that if the eye, ill controlled by the patient or surgeon, should, in any stage, roll upwards,

as it has a tendency to do, the instrument in hand may not pass downwards into the deeper parts of the eye, but be forced out of it by this movement. The iris now being in position, the pupil clear, and nothing being left between the edges of the corneal wound or within the palpebral aperture, the lids are gently closed, a smooth oblong piece of linen rag, with a slit in it for the nose, is placed over both eyes, then a little wool is put in the orbits over the rag, and a bandage over it round the head. The patient is kept in bed for a day or two, and fed with spoon-meat. He may then get up and walk about the room a little.

Extraction with a Traction-Instrument.—In this operation chloroform is given, and a wire-speculum to keep open the lids, and forceps to hold the eye, are used. The surgeon either thrusts in at the upper part of the sclerotico-corneal junction a lance-shaped knife in his right hand, or, what is preferable, the point of a Sichel's extraction-knife, at the right extremity of the incision which he intends to make in this part of the eye, and, holding it almost vertically, he cuts on as far as he intends, perhaps one-fourth of the circumference, to the left. He then makes a considerable iridectomy, larger than for artificial pupil, and not so large as in a case of glaucoma. Then with the pricker he lacerates the lens-capsule. He then passes the end of the traction-instrument (Critchett's spoon) between the lips of the wound, vertically, to the upper edge of the lens and within the capsule, rather posteriorly; and, remembering anatomically the curve of the hinder capsule, he passes it along this curve just behind the lens itself. He then tilts forwards the end of the spoon, and, watching that the lens is coming with it, he begins to withdraw the instrument and the lens together. If the spoon will not go on between the lens and its capsule, it may be passed perhaps a little sideways; and as soon as it has begun to pass between the two, it may be passed all the way without difficulty. If the lens is being pushed before the point of the spoon, instead of the latter passing behind it, it will be seen, the front surface of the lens being purposely watched, to be passing downwards; and we must try some other way, sideways, as above directed, or further backwards, and not, of course, push on the instrument so as to displace the whole lens downwards. The piece of iris excised must be so large that what is left does not become compressed between the spoon and the cornea, in the removal of the lens; and the corneal opening must be so large that not much dragging is required. The main body of the cataractous lens being extracted, the concavity of the posterior capsule, in which it rested, is pressed forwards by the vitreous body behind it, and so, if any fragments of opaque lens be on it, they are presented forwards in the pupil, and a spoon may be employed once or twice for their removal. No blood-clot, or any lens matter, or, of course, the edges of the iridectomized iris, must be left in the corneal wound.

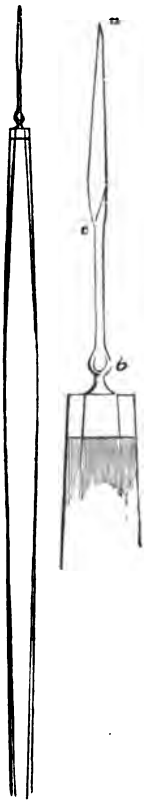
Extraction by Von Gräfe's Method.—An operation for hard cataract has been introduced, and is now generally practised, by Von Gräfe of Berlin. He has sought to do away with the necessity for the introduction of any traction-instrument within the eye, and, excepting in some cases, he does not now use any; if he does, in any case, it is a small blunt hook instead of a spoon. He evacuates the lens, pressing the back of the curette against the sclerotic margin of the incision, so as to make the wound gape there, and making the necessary counter-pressure below with the fixing forceps. He makes an iridectomy, and leaves a flap of conjunctiva attached to the corneal flap to cover the incision. The incision is made with a knife like a sharp-pointed tenotomy-knife, by puncture and counter-puncture, of perhaps one fourth of the circle of the sclerotico-corneal junction. The capsule is, of course, lacerated as usual. The cortical lens-matter generally remains to be removed after the nucleus has come out or has been removed by the hook placed under and around it. Von Gräfe says that the advantages are the following: 1st, the incision is linear; in consequence of which the coaptation of the edges of the wound is more perfect than is the case after a flap incision, and there is less risk of gaping of the wound, permitting loss of vitreous humor after the performance of the operation; 2d, it is peripheral, passing chiefly through a vascular texture in which the healing process occurs more rapidly than in a non-vascular tissue; 3d, the incision may be viewed as subconjunctival, being covered by a flap of conjunctiva; 4th, a portion of iris is removed, and thus no prolapse of iris can occur, and the tendency to iritic inflammation is diminished; 5th, in most cases no instrument is introduced to assist the evolution of the lens, and, when such is

necessary, a hook merely is employed; and 6th, the after-treatment is of short duration.

Needle-Operation.—This is the method to be preferred for *soft* cataract at any age, so that we have only to determine which is a soft cataract. It is not often found but as "congenital" cataract or in traumatic cases in young persons. Diabetic cataracts are soft. If a middle-aged or elderly person have soft cataract, it is bluish-white, rather uniform in color; it has no nucleus; and, especially, it is not at all amber-colored. If in any cataract case a needle-operation be necessary, it should be done at once. The earlier in life, and the sooner after the commencement of the cataract, the more quickly it will be absorbed afterwards. Infants, unless at the time very young or sickly, should be operated on, or their eyes get wandering oscillatory movements as a confirmed habit in after life; and infants particularly well bear the risks of swollen lenses. The immediate result of the use of the needle in this operation is, that the cataractous lens becomes very much increased in bulk by the admission of the aqueous humor within the capsule.

Operation.—The needles used should be very fine, and should not let the aqueous humor escape beside them. [A very good instrument for the purpose is the knife-needle devised by Dr. Isaac Hays of this city, and represented in the accompanying figures (*Am. Journ. Med. Sciences*, July, 1855, p. 82.—A.] The pupil is to be dilated with atropine. Chloroform is hardly necessary. A stop-speculum is inserted between the lids, to keep them apart, and fixed in position; and the little fold of conjunctiva and subconjunctival tissues is to be seized with the toothed forceps just below the cornea or opposite to the point at which the needle is to be introduced as may be most convenient, to steady the eye. The needle, in the other hand, is made to enter the anterior chamber through the cornea, at some part near the margin, wherever it may seem best, probably at the upper and outer part; it must not be passed very obliquely through the coats of the cornea, or in its use they will be much twisted. The point is then carried on down to the centre of the lens, which is nearer to the cornea according to the youth of the patient, and made to enter its substance a little way, and the capsule is torn open by moving the needle-point in various directions to and fro. If the operation be performed for the first time in a very young patient, the lens is readily broken up superficially and not extensively. It soon afterwards swells up very much, and therefore but little should be done. If the needle be passed far into the substance of the lens towards the nucleus, it will, unless the patient be very young, become fixed in the denser substance, and the lens will move about as a whole on the needle. If the patient be older, or has been before operated on, one needle will not freely lacerate the anterior capsule, and two may be required. The fixing forceps must be intrusted to an assistant; or, one needle being entered some distance in the anterior chamber, it may be used, the patient being then quiet, for an instant, as a fixing point, holding the eye forwards, until the needle in the other hand has been also entered, and then the eye is perfectly under command. If one needle only be required to be used, it is better to use neither speculum nor forceps, but the fingers of the other hand (Fig. 395) instead of both, unless the eye be small and deep in the orbit. If two needles are to be used, the speculum should be employed, and then, choosing an opportunity when the eye is still, one needle, and then quickly that in the other hand, is introduced and the operation completed with the two needles, opening out the lens, whilst at the same time they keep the eye steady.

[Figs. 400. 401.



Hays' knife-needle.]

In a few weeks, more or less, the lens-matter, which was bulging, no longer protrudes; the surface is perhaps rather flattened, and the situation of the opening made in the lens-capsule is somewhat excavated. The needle then may be used again; and at the second or at least the third time of using it, after sufficient intervals, there is no fear of the remaining lens-matter swelling enough to bring about

any inflammation, and it is much more unlikely now that a fragment of len be detached and so set up inflammation. Hence the needle may be used in operations more and more freely each time. And the needle must be e whenever the bulging-out lens-matter no longer protrudes, and the woun lens-capsule seems to be a little excavated; for, if the repetition be long the lens-capsule in front may become so tough that it can never be the broken up, and it will be drawn in at the edges of the surgical wound, e some portions of white opaque lens-matter which, if not in the centre so a struct vision, will show when the pupil is large, and are a defect, in appear the good result to be expected by timely interference. If the capsule be tou the lens will perhaps move about on the end of the needle as it is moved abo the lens-capsule is no more torn open. A second needle must then be int from the opposite side of the cornea, and then with it the lens may be h steadied while the needle in the other hand tears open in various directi capsule, and breaks up the lens-substance freely; or, if it be very tough, needles, introduced from each side of the cornea, and meeting at the same a in the lens-capsule, have their points separated, so as to make a large rer The posterior capsule is throughout to be carefully preserved from any acc wound. If it should be wounded, whilst the lens is still bulky and softened, let the vitreous body come forward, and protrude in the midst of the lens-c the vitreous body pushes aside the fragments of broken up lens against the i ciliary processes, and mechanically sets up inflammation, which commonl badly. It is very difficult—if not impossible—to remove such fragments curette or the syringe without injuring the vitreous body, which lies in the w will, however, be better to lose some vitreous humor than to leave much lens-m pressing upon the iris, &c., if such a mishap should occur, and the fragments removed. In the *final* stage, however, of keratonyxis (as the operation ha called), very little of the lens being left, the carefully preserved *posterior* lens-ca has not unfrequently to be purposely torn open, and a rent, through whic vitreous body protrudes, to be made; for small opaque fragments often remain this capsule, after most of the lens matter has been removed little by little; o cate gray webs and streaks or puckerings appear in or upon it, visible, perhaps, by use of the oblique illumination, and yet interfering very much with good v There are now no fragments of lens to be displaced and excite inflammation.

In old people, or even in adults, a needle-operation is a very tedious process lens matter, though swollen, has irregular hard margins, and will very likely s inflammation of the iris and ciliary processes, &c. A detached chip of the senile cataract will be very likely to do the same; and elderly people in any in mation of the eye are always more likely from their age to get a glaucomatous plication of the disease. But if a young adult have one useful eye, a cataract other may be got rid of by repeated use of the needle, doing each time very with it; and the process, tedious as it is, is safe from the greater risks of extrac and the inconvenience of the delay, in such a case, will not be felt.

Suction-operation.—Fluid cataracts are sometimes, but not often, found whole contents of the lens-capsule being evacuated into the anterior chamber the capsule is torn open with a needle. They occur, perhaps, in young adul whom we should use the needle. They look like soft cataracts; and they can h or unfrequently be distinguished from ordinary soft cataracts, besides that their rarity they are not expected. They appear of a uniform color. Some like them surgically are the cataracts of diabetic patients, though these latte not fluid, only very soft, so that, after the needle has been used, although the pa be middle aged, the whole of the lens is mixed up in the aqueous humor, and ca and indeed it must be, removed forthwith. In this I am speaking of my recen perience, in which I have had a succession of cases of diabetic cataract, all and all successfully treated as described below. I do not say that all diabetic racts must be like those to which I refer: they were of a bluish milky color, large, apparently pressing forwards the iris, with some broad, convergent, tinctly glistening striæ anteriorly, rather lighter in color than the body of th itself. The syringe is also available in the cases of wounds of the lens in childr young adults, in which, soon after the injury (or a first needle-operation), in a or thereabouts, the whole lens is much swollen altogether, and in cases where, subsequent needle-operation, it has been completely broken up and has becom

formly swollen and diffluent. The operation is a very admirable one, and, if practised carefully in the above-mentioned cases, it deserves more consideration than it has obtained. Diffluent lenses used to be evacuated by the curette; a sufficiently large opening having been made with a broad needle, the curette was introduced into the anterior chamber, and a gush of the aqueous humor and lens-matter took place, and then, by various little movements to and fro, a little more of the lens-matter was made to flow along the groove of the instrument. Now, in such a case, by using the syringe, with the end like that of a curette, but made tubular, keeping the point of it in the posterior aqueous chamber, and the orifice being forwards, we can, without any movements endangering the iris, suck out the whole of the diffluent lens-matter. The corneal opening is made with a broad needle, which should be made to enter also the lens and lacerate the capsule. It should be large enough easily to admit the suction-curette; and the point of this, when once introduced, should be brought into *the centre of the pupillary area*, and then carried back until it is *in contact with the posterior lens-capsule*. When there, the point *should not be moved about*, or it may draw in the iris, or, afterwards the cornea, with the lens matter, or bruise the iris. The patient being recumbent, and the point of the instrument kept well back in the posterior aqueous chamber, in the hollow of the posterior capsule, all the diffluent lens-matter will fall towards the orifice and be drawn in succession into the syringe. If, in a case of a traumatic or surgical traumatic cataract, the surgeon cannot be sure that it is well dissolved in the aqueous humor, after a lapse of time amply sufficient according to the age of the patient (the older the patient, the slower is the cataract in becoming dissolved in the aqueous humor), it will be better to defer the use of the syringe until some evidence of irritation, redness in the ciliary region, &c., shows itself. In no case would it be necessary to wait more than a week or ten days; but, if the lens-matter be imperfectly dissolved, some fragments clog the small tube of the syringe, and then it is necessary to remove the instrument from the eye, and reverse the action of the piston so as to force out the fragment causing the obstruction in the tube of the syringe. This necessitates the introduction and reintroduction and various movements of the syringe, almost as much as used to be required with the old curette in the anterior chamber.

The suction-curette is invaluable, especially for the total removal of the whole lens at once, without any previous needle-operation, by a very small opening in the cornea, in diabetic and other exceptional cases of cataract; and next in those in which the preliminary operation (or an accidental wounding of the lens) has, after a while, made it possible and desirable thus to remove the lens in a larger number of cases; for, with the suction-curette, the corneal opening need be only very small, and the parts concerned little disturbed. It is also, in different cases, sometimes useful in other operations for cataract, in cases where the old-fashioned open curette would have been used, so as to employ suction-power instead of traction, &c. Whenever a cataract has been removed by flap extraction or smaller corneal section, and soft cortical matter and shreds of lens-capsule remain, less injury to the parts is probably done by the use of the suction-curette than by the old curette or other traction instrument; but the latter must be used in many cases when the cortical matter, &c., is not very soft, and the suction-curette becomes clogged. As to the shreds of lens-capsule and lens-matter involved, the grooved curette cannot possibly remove them, and considerable fragments of lens-matter cannot be removed with either the suction or the grooved curette, so readily as with a scoop. The grooved curette acted best when, with the first gush of aqueous humor along its groove, the opportunity was taken to let pass along with the aqueous humor as much as possible of the diffluent lens. Now, with the suction-curette there is no voluntary gush along the tube of the instrument when it is introduced, only beside it perhaps, and the space beside it is not large enough to let pass any but the smallest fragments that may come in the way; so, not to lose the best opportunity, the natural force of expulsion and the greater quantity of fluid contents, we must begin to employ the suction-power as soon as possible after we have entered the suction-curette in the anterior chamber, or the aqueous humor without the lens-matter may be running to waste.

EXTIRPATION OF THE EYEBALL.

If an eye be rendered useless, especially if in consequence of some former injury, it is probably best to remove it; certainly if any irritation or inflammation exist in the other eye, or if it be unsightly, or if there be any foreign body remaining within it, or the patient be one who cannot probably, at a future time, at once obtain good advice when sympathetic irritation may have arisen. In the latter case, that of the laboring man or of the needle-woman, the sight of the seeing eye will be secured; and, then, even if the patient cannot afford an artificial eye for the future, the deformity of a vacant palpebral aperture is comparatively of very little importance. But if, when the least occasion may arise, the patient be in the way of good advice and be duly convinced of the importance of not neglecting any trifling and transitory pains and obscurations in the sound eye, and the one lost be also in appearance an eye, it may be left. In some cases, that are not urgent, the value of appearances may turn the scale in determining whether or not to recommend extirpation. The probability of much pain to be experienced in a disorganized globe would decide the question in favor of the operation. And, whenever it is to be recommended, it must be strenuously urged; and, if it be not adopted, the responsibility of the decision must be plainly made to rest with the patient. Sympathetic irritation in a blind eye may be allayed, but the sympathetic inflammation, following the loss of an eye for practical purposes, by old injury or deep-seated inflammation, is the most terrible and intractable and destructive with which we are acquainted. And if it be subdued, it will recur: each time with some more impairment of vision afterwards. An eye totally blind will never see again. And, with a good artificial eye adapted, the deformity of the extirpation will not be much.

The Operation is thus done. When the patient is under the influence of an anæsthetic, a (spring) wire speculum is inserted between the lids to keep them open; the conjunctiva is seized with toothed forceps, at any part near the margin of the cornea, and a small opening made in it with rather blunt-pointed scissors. In the next place, the conjunctiva is to be divided all around the cornea. This may be done by inserting one blade of the scissors beneath the conjunctiva where it has been opened, and with the forceps drawing the globe one way or the other, as may be most convenient; or, with it, seizing the conjunctiva at the part to be cut through, if it be too closely adherent to the subjacent part to allow of the passage of the point of the scissors. Or the strabismus hook (Fig. 393 *d*), inserted at the opening made in the conjunctiva, may be carried round the cornea, and the conjunctiva, raised a little in this way, may be conveniently cut through. When the circular incision of the mucous membrane is completed, the subconjunctival tissues, seized at different parts in the wound, are cut through with the scissors, the points being directed backwards and kept as closely as possible to the globe. An opening still deeper, close to the globe, in some part of the circumference of the wound, is made with the scissors, and then the strabismus-hook is passed beneath the tendon of one or other of the rectus muscles, which is divided, and so are then the other tendons in succession and other intervening parts close to and connected with the globe. The tendons of the oblique muscles being directed to the temporal side to be inserted, the hook must be directed outwards and kept very close to the globe to secure them. But only the four rectus muscles are generally worth a separate search. All the tendons being cut through, the divided ocular insertion of the internal rectus is seized with the forceps and the eye drawn outwards; a pair of scissors curved on the flat (Fig. 393, *e*) is carried down beside the globe on the nasal side, as, on this side, the optic nerve is most easily reached; the scissors are opened a little and advanced, and the nerve is at one stroke divided. The globe now generally comes forward suddenly. It is drawn forward by holding it at the point of insertion of one of the rectus muscles or wherever it may be secured conveniently, and any remaining adherent soft parts are divided, always of course as before, close to the globe. Dixon finds it convenient to leave the insertion of the internal rectus muscle to be at last divided after all the other muscles have been cut through, and the optic nerve also. Sometimes, if the globe be staphylomatous or enlarged, so that after the division of the rectus tendons it is difficult to reach further back with two instruments within the comparatively small palpebral aperture, it is convenient then to remove the spring-speculum, and with the points of the fingers within the two lids to force them backwards, so that the eye comes to stand out in front of the

lids; and this being done, the optic nerve may be easily reached with the scissors and divided, and the remaining soft parts dissected from the globe. Or it may even be necessary to enlarge the palpebral aperture at the outer canthus, or to evacuate some of the fluid contents of the eye. After the four rectus tendons have been divided in this operation, the removal of the globe should be completed as quickly as may be, to prevent loss of blood, or its being extensively effused in the orbital and palpebral areolar tissue; for, if the latter takes place it is so much the more difficult to reach the deeper surrounding parts to divide them, and the wound is longer in healing, and the lids of the patient are for so much the longer time discolored afterwards. Hence we must stop the bleeding as soon as possible after the globe is removed from the orbit. The most effectual way is, perhaps, the speculum being still within the lids, or reintroduced, to have a basin of cold water brought, and a sponge full of it held at some height, so that the water falls from it in a continuous stream and with some force into the vacant orbital space, a large empty sponge being also placed against the temple of the side of the extirpation to receive the flow of water. It should be continued until the oozing of blood from between the lids has ceased. Then a small round empty sponge, compressed to make it go between the lids and a little way into the orbital space, is placed there, and confined very closely with a bit of cotton bandage, tied tightly round the head, the knot over the sponge, and this should be left so for six hours. It then may be removed, and simple water-dressings applied until the wound is healed. When this is complete, if a glass eye is to be worn, it should be adapted at once, for after a time the lids, left unsupported, will not contain one of full size, and the parts will less readily accommodate themselves to the new state of things, the puncta are misplaced, and the lashes inverted and a source of irritation. The soft parts, including the muscles that surrounded the eye, removed, will form a cushion on which the artificial eye rests, and some little power of motion will thus be given to it; less, of course, than after the operation, next to be described, of *abscission*, or than in those cases in which, generally in former times, an artificial eye was employed, those, namely, in which the stump of an eye, lost accidentally or by the ill-result of some surgical operation, was left and was suffered to remain behind the lids.

As to the old operation for extirpation of the globe, in which a great part of all of the surrounding contents of the orbit were, with it, removed with a large knife, it is never necessary, and therefore it is never done by able surgeons, except in cases in which a malignant growth has penetrated the coats of the eye, and extended more or less into the soft parts around. Then these parts may be widely cut away, when the globe is excised, with a knife or scissors, as may be most convenient.

Abscission.—A few years ago this operation was much more in use than it now is. It is applicable to cases in which there is no essential pain, in which the disease, *staphyloma corneæ* generally, is confined to the front of the globe, so that, by this operation, at least probably and mainly, all the parts diseased may be removed. But there are many cases in which abscission or excision, one or the other, is called for; and in these cases, generally, excision is now thought advisable. In the cases of great staphyloma corneæ, the deeper parts are only comparatively sound, and, after abscission, the stump made by the operation, though one is very careful to remove the ciliary body and lens, does not seem to be unlike some of the accidentally wounded and shrunken globes that always must be excised when the occasion arises. The cases of corneal staphyloma are generally those of young persons, to whom their personal appearance is more important than to those more advanced in years. The stump of an eye left, if it can be so made useful, is a much better foundation for an artificial eye to be worn upon, than is the cushion only of the soft parts left by excision, and the ocular muscles have a definite insertion. The healing of an abscissed globe is tedious, and perhaps painful; whereas there is no trouble or anxiety whatever about the healing after the excision of an eye. But few comparatively of our *hospital* patients will or can have the opportunity in future years of continuing to provide themselves with an artificial eye, every year or two when a new one is required. And it is absurd to do an abscission in any case unless the patient intends to wear a glass eye; he had much better have the offending globe removed at once and altogether.

Operation.—An incision, oval horizontally, through the sclerotic and other coats of the eye, is made to inclose the cornea, ciliary body, and lens, all of which are removed together. Sutures may or may not be used to draw the sides of the gap

together, from above and below, to retain better the vitreous body, to hasten the time of healing, and leave a better shaped stump and smaller scar. But the sutures sometimes give much pain and keep up inflammatory symptoms during the protracted healing. Supposing they are employed, three or four stout and semicircular curved needles, each with a silver-wire or black silk thread, are inserted in a row above the cornea, at about half an inch from the corneal margin. These are respectively carried at some distance behind the ciliary body and lens, and brought out below the cornea at about as far from the corneal margin as they were when introduced. Then a puncture is made with a pointed knife through the coats of the eye at about half an inch external to the margin of the cornea, and by it one blade of a blunt-pointed scissors is introduced, and so an oval piece of sclerotic, including the cornea, &c., is removed altogether, and just within the points at which, above and below, the needles traverse the sclerotic. Then the needles are drawn through, and the sutures are tied in knots each to each.

THE OPHTHALMOSCOPE.

The use of the ophthalmoscope, in a surgical point of view, has been alluded to (p. 826, *et seq.*).

Fig. 402 represents the way in which I recommend the instrument to be used. The patient rests and steadies his head against a high upright backed chair. (*Ophthalmic Hospital Reports*, vol. iii. p. 64), and the observer standing before him, can easily move his head, not only from side to side, as when he is seated in the way usually recommended, but he can as easily look from above or below; and this is more convenient, as he can more easily command his own movements than those of the patient's eyes. The best common ophthalmoscope is Liebreich's. It has a

Fig. 402.

Use of the ophthalmoscope.

small, polished, slightly concave metal mirror, reflecting enough light, but less of course than a silvered glass mirror, which moreover is usually made larger. The silver plate has a rather small central aperture, which is well defined as compared with that bored through the thickness of the glass plate. The mirror is framed and backed in thin brass, painted black. A short black handle is appended, and to one side of the frame is a clip, to hold behind the hole in the instrument one of various small lenses, which are supplied with the ophthalmoscope. This clip is hinged, so that the lens contained by it can be turned aside when it is not required

to be used. The mirror is held, as in the figure, to the right eye, to examine the right eye of the patient, and *vice versâ*, with the handle horizontal, the little finger extended for the patient to look at, which if he does, then the observer (unless also the eye that is being examined is squinting) has in view the optic nerve entrance in the fundus of the eye. And this is the best starting point, although the rest of the deeper parts of the eye remain to be examined. It is best to begin the use of the ophthalmoscope in the normal eye (the pupil dilated with atropine) of a young person of fair complexion. First, a reddish glare is seen, and this is lighter at the optic nerve entrance. Then, in order to perceive the details of the fundus, the lens, held in the free hand of the observer, is brought before the eye that is examined at a distance of a few inches, and moved all ways in the line of the reflected light of the fundus, until the best image is obtained. This hand may be steadied against the cheek of the patient. This mode of ophthalmoscopic examination is the "indirect," (inverted image). It is that usually employed. Some practice with the ophthalmoscope is necessary before proceeding to examine the deep-seated morbid appearances within the eye.

With the ophthalmoscope I have, more than once, detected a lens or cataract dislocated by a blow into the vitreous chamber, and lying at the bottom of that space, and gravitating perhaps to either side. Operation follows, of course, in this case the diagnosis afforded by the ophthalmoscope. Dixon (*Ophthalmic Hospital Reports*, vol. i. pp. 280–5) reports a case in which he discovered by the use of the ophthalmoscope, in the ordinary way, a foreign body (a chip of metal) entangled in some remains of blood-clot hanging in the vitreous chamber. Thus aided, and having perfectly satisfied himself of the exact position of the foreign body, he made an opening through the sclerotic at a point opposite to that at which it was suspended, and succeeded in removing it with forceps. Also it is indispensable, previously, in operations for evacuating the fluid of detached retina. Bader uses it, indeed, whilst he is actually operating. That is to say, he passes a long needle in through the sclerotic, &c., at a point opposite to the most prominent part of the detached retina, and, looking through the ophthalmoscope, he makes the needle enter this prominence; then he gives to an assistant the ophthalmoscope, to direct the light into the eye; then he passes a second similar needle, also through the sclerotic, at a third of an inch from the first, and, not passing it further in than the first, he directs it to the same spot, so that it may also enter the detached retina; and he makes them touch. Finally, by approximating the handles, without any other change of position of the two needles, he makes the rent in the retina. To be sure that this is done, he withdraws now the second needle, and examines the fundus again with the ophthalmoscope himself, to see if the subretinal fluid has entered the vitreous chamber, to see the rent if possible, or some evidence of the success of the operation. If there be none, he re-introduces the second needle, to repeat the operation.

CHAPTER LVII.

DISEASES OF THE JAWS AND THEIR APPENDAGES.

DISEASES OF THE GUMS AND ALVEOLAR PROCESSES.

Abscess of the Gums is of very frequent occurrence, from the irritation of decayed teeth. Here a free and early incision should be made; which, by giving exit to the pus, will afford immediate relief.

Spongy and Sloughy Ulceration of the Gums, will occur as the result of constitutional cachexy induced in any way—by mercury, malaria, syphilis, &c. It is best *treated* by tonics, in conjunction with the chlorate of potass and mineral acids internally. If it spread actively, escharotics, such as hydrochloric acid or creasote, may be advantageously applied. If it do not make much progress, a solution of nitrate of silver, with chlorinated or tannin gargles, will be useful.

Simple Hypertrophy of the Gums, in the form of a pendulous fringed outgrowth overlapping the teeth back and front is occasionally met with in young children. Such a growth requires to be freely removed with scalpel or scissors. In a case of this kind under my care, it was found to consist of the ordinary structure of which the gums are composed, with a fine fibrous stroma containing much gland-tissue; the papillæ on the surface were very large, and covered by unusually thick epithelium.

Epulis is a tumor springing from the periosteum and edge of the alveolus, and implicating the osseous walls: it grows up between and loosens the neighboring teeth, which it displaces and envelops in its structure. It is of two kinds; *simple* and *malignant*. The *simple epulis* is a fibrous tumor; the *malignant* is usually myeloid—if the term "malignant" can be applied to that form of tumor; but it is also occasionally cancerous.

Epulis is most frequently met with in the lower jaw (Fig. 403). I have, however, seen several instances of it springing from the alveolus of the upper jaw (Fig. 404). It appears chiefly to be occasioned by the irritation of decayed stumps, and hence is more frequently met with in connection with the molar than with the incisor teeth. Although this disease has occasionally been met with in children, it seldom occurs before the adult age, and then may be developed at any—even up to an advanced—period of life. It is seen then as often among females as males. A fibrous epulis appears as a red, smooth, and lobulated tumor, at first hard and semi-elastic, like the ordinary structure of the gum, but after a time softening by disintegration, and ulcerating on the surface, with a purulent or sanious discharge. The fibrous variety appears simply to be a circumscribed and rapidly growing hypertrophy of the gum.

Fig. 403.

Epulis of lower jaw.

Fig. 404.

Epulis of upper jaw, hanging down so as to overlap the lower jaw.

Treatment.—The treatment of epulis consists in the removal of the whole of the mass and of that portion of the alveolus from which it springs. As it evinces a great tendency to reproduction, it must not simply be shaved off the bones, but a portion of the osseous structure must be removed as well; unless this point be attended to, the growth will to a certainty be reproduced. In all ordinary cases of simple epulis, the removal may be done from the inside of the mouth without the necessity of making any incisions through the cheek. In very large masses of epulis, more particularly of the myeloid variety, and extending towards the ramus, it may be necessary either to carry an incision from the angle of the mouth downwards and outwards, or to dissect up the cheek from the bone, and thus expose the disease fully. In performing the operation, the first thing to be done is to extract a tooth contiguous to and on each side of the tumor; a cut must then be made with a saw through the alveoli of the teeth that have been removed, down to a level with the base of the growth. In doing this, care must be taken not to cut too near the remaining teeth, lest the alveoli be opened and their support lost. If the tumor be large, it may be necessary to saw deeply; but the base of the lower jaw should, whenever practicable, be left intact, the whole of its substance not being sawn through, so that, though a considerable portion of bone be removed, yet the length of the jaw may be preserved. For this purpose Hey's saw should not be used, as it is a niggling instrument, difficult to manage in this situation; but a straight and stiff-backed saw, with as deep a blade as the mouth will conveniently admit, will be found most useful (Fig. 282). The epulis, included between two vertical cuts, may now, if small, be removed with cross-cutting forceps, and the bleeding stopped by placing a plug in the wound and compressing it against the teeth of the upper jaw by means of a bandage passed under the chin. If the epulis be large, a horizontal cut should be made along the bone about midway between the alveolus and the base, by means of a Hey's saw; and, after the bone has been penetrated to a sufficient

depth, the blade of the cross-cutting forceps may be fixed in this cut, and the diseased part then removed. Should there be a spouting dental artery, it may be necessary to apply a red-hot wire, or the perchloride of iron, in order to arrest the bleeding. The cut surface will speedily granulate; and the cavity fills up with fibrous tissue. The operation for the removal of epulis is a very safe one. Of 28 cases collected by Hutchinson from different London hospitals, one was fatal; and that one from pyæmia.

Malignant epulis.—Cancerous ulcers and fungous fibro-plastic growths from the alveolar processes, *malignant epulis*, as they are called, occur in the same way as the last; but they are soft, purplish, very vascular, grow rapidly, and are speedily reproduced after removal; they principally, so far as my observation goes, occur in males advanced in life. The same operation requires to be practised for these diseases as for the simple epulis; and, as there is usually much hemorrhage following their removal, a red-hot iron must be applied to the bleeding surface. If a malignant epulis be of very large size, it may be necessary to remove a portion of the whole thickness of the bone, through an external incision, as will be described in the section on excision of the lower jaw (p. 865).

Necrosis of the Jaws is commonly the effect of blows, of salivation by mercury, of syphilis, of fever, or of exposure to the fumes of phosphorus. I have, however, seen the disease occur idiopathically in otherwise healthy subjects, without any assignable cause. In this way I have seen the whole of the alveolar process of the upper jaw exfoliate in a young lady, otherwise perfectly healthy; and I have several times had occasion to remove large portions of the lower jaw—in one case more than half of the bone—for necrosis that was not referable to any of the causes mentioned above, or, indeed, to any assignable reason. The disease begins with deeply seated pain resembling inveterate toothache, which nothing will allay; the gums become swollen; the teeth are loosened, and eventually drop out. Before they do so, however, pus usually wells up through the alveoli. Abscesses form inside the mouth and under the angles of the jaw, having fistulous openings through which bare bone is reached by the probe. The general health suffers greatly in these cases, more so than in necrosis generally, doubtless in consequence of the patient swallowing some of the pus from the dead bone.

Necrosis of the jaws, arising from the inhalations of the fumes of phosphorus during the manufacture of lucifer matches, first noticed by Lorinser of Vienna, has been especially described by Von Bibra and Geist, who had abundant opportunities of observing the disease at the large manufactories at Nuremberg. This *lucifer match disease* has of late years also been observed in many cases in this country. It consists in necrosis of the jaws, and is attended by the symptoms just described, but in a severer degree and an acute form. Both jaws are equally liable to be affected; but commonly one only at a time is diseased, and the whole of the bone may die and be separated. Thus, of 51 cases observed by Von Bibra, both jaws were affected in 5 instances only—the upper alone in 21 cases, the lower in 25. It appears that workmen having sound teeth are not easily if at all influenced by the fumes; but, if any tooth become carious, then the effect of the fumes will eventually manifest itself by the induction of necrosis, the action extending probably through the carious tooth into the interior of the alveolus.

Treatment.—The treatment of necrosis of the jaws presents nothing special. The removal of the sequestra should be effected as far as practicable through the interior of the mouth, by free incisions through the gums.

In the *upper* jaw, where the necrosis seldom extends beyond the alveolar border or the palatal process, this may always readily be done.

In the *lower* jaw, the question as to whether the dead bone should be extracted through the inside of the mouth, or by incision from without through the cheek, will be determined partly by the position of the sinuses and partly by the situation and extent of the bone affected. This may in a great measure be ascertained by the situation of the sinuses leading down to it. If these be in the cheek, or in the side of the neck, or under the angle of the jaw, it is usually an indication that, if the whole of the corresponding ramus or body of the bone be not involved, the posterior and outer parts are certainly affected; and, in these circumstances, extraction of the sequestrum is best effected by opening up the sinuses parallel to the line of the jaw, and removing the necrosed bone in the usual way. The incisions for this purpose need not usually be very extensive. If the operation be delayed, in accordance with

those principles that guide us in the management of necrosed bone generally, until the sequestrum is quite loose, it may usually be readily extracted, in whole or in pieces, through an opening that will leave but a small cicatrix. By such operations as these, the whole of the lower jaw has been extracted piecemeal at intervals in a state of necrosis, first on one and then on the other side. Carnochan has removed the whole of the necrosed lower jaw at one operation, disarticulating first one and then the other condyle in the usual way.

If, however, there be no external abscess or sinus—if the gum have been loosened and perforated, with a ragged portion of sequestrum projecting through it into the cavity of the mouth, then no external incisions will be required, but the dead bone may be readily removed from within the mouth. Large portions of the jaw may thus be removed. I have taken away the whole of the ramus with its processes, entirely through the gums, without any external incision: and, in a negro, the whole of the bone in a state of necrosis has thus been removed in separate pieces, by Perry, through the inside of the mouth.

[Dr. William Hunt, of this city, removed some years since the greater portion of the lower jaw, in a case of phosphorus necrosis, without any external incisions, and Dr. Charles S. Boker shortly afterwards succeeded in removing the entire jaw in the same manner. (*Am. Journ. Med. Sciences*, April, 1865, pp. 353 and 555.) Dr. Hunt's patient was presented at a meeting of the College of Physicians eight months after the operation, and at that time very considerable regeneration of bone had occurred (*Loc. cit.*, Jan. 1866, p. 163.)—A.]

The amount of regeneration of bone will depend greatly upon the state of the periosteum before the removal of the sequestra. If this be healthy, and if new bone have already formed prior to operation, a very perfect reproduction of the portions of jaw removed may take place. Should no new bone have formed before the operation, a dense fibroid cicatricial structure will replace the removed bone.

DISEASES OF THE ANTRUM AND UPPER JAW.

Our present knowledge of diseases of the jaws, and of the operative procedures necessary for their removal, is chiefly due to the labors of Gensoul and of Liston. O'Shaughnessy, also, who appears to have had many opportunities of witnessing these affections amongst the natives of India, has added much to our acquaintance with their pathology and treatment.

The various large and irregular cavities that lie amongst the bones of the face may become the seat of disease, primarily originating either in the mucous membrane by which they are lined, or in the osseous structures that compose their walls. In this way the frontal sinuses, the ethmoidal and sphenoidal cells, and the antrum, may either be seats of chronic inflammation of their mucous linings, with more or less profuse muco-purulent discharge; or the mucous membrane may take on more serious organic disease. Thus epitheliomatous, fibroid, or fibro-plastic or cancerous tumors may develop from it, and, after distending the cavity in which they were originally formed, may thin and destroy its osseous walls; and thus, passing outwards into other situations about the face and the base of the skull, where they are freed from the pressure of surrounding bone, they may take upon themselves greatly increased development, blocking up mucous canals, as the nose and the lachrymal sac and ducts, displacing the eye, and producing great disfigurement of the side of the face. These secondary developments, from the rapidity of their unrestrained growth, and the amount of deformity and distress which they occasion, may readily be mistaken for the primary disease, the real starting point of which will often be found in a deeper and more limited locality. That the bones constituting the walls of these cavities may also become the original seats of morbid deposits, more particularly of the enchondromatous, myeloid, and encephaloid kinds, there can be little doubt. These deposits run a similar course to those originating in the mucous membranes.

Dropsy of the Antrum, from accumulation within this cavity of glairy mucus like the contents of a ranula or ganglion, or of a thin brownish serous fluid containing cholesterine, occasionally occurs. In some cases this distension of the antrum appears to be simply the result of the accumulation of its natural secretions; for, as the aperture leading from this cavity into the nose is a little above its floor, there may be a natural tendency for the fluid secreted here to accumulate to some

extent before it is discharged; and if this aperture be from any cause blocked up, the secretion may increase to so great a degree as to occasion serious inconvenience by its outward pressure. But in other instances the accumulation of fluid is of a serous and not a mucoid character, and the disease is evidently a true cystic development in the part, with an active growth independently of distension. In such cases the accumulation of fluid may after a time expand and absorb the osseous walls of the cavity, so as to constitute a true cystic disease; and in this way the cheek is rendered round and prominent—an indolent semi-elastic tumor forming in it and protruding it outwards, and giving rise to the egg-shell or parchment-like crackling on pressure (Fig. 405). The floor of the orbit or the roof of the mouth may be caused to bulge, and the nasal cavity may be encroached upon.

Fig. 405.

Dropsy of antrum.

Treatment.—When the accumulation of fluid is but small, with moderate expansion of the superior maxilla, catheterism of the antrum may be practised by passing a curved probe along the side of the nostril between the superior and middle turbinate bones; where, in the middle meatus, about its centre, the aperture leading into the sinus may be felt. Should this treatment not succeed, or should the anterior wall be much expanded, the antrum must be opened from without: this is done without incising the lips or wounding the face, by thrusting a trocar and canula into the most thinned and expanded part of the tumor under the cheek; or, if necessary, by dissecting up the cheek from the gum, and thus making an opening into the cavity of the antrum with a strong pair of scissors or a perforator, through its most expanded and thinnest part, so as to allow the discharge to escape freely. In order to prevent a re-accumulation of the fluid, it will be better to cut away a small portion of the thinned and expanded wall of the antrum, and thus to establish a permanent aperture in it. The shape of the cheek may be restored by the gradual pressure of a spring pad or double-headed roller.

Suppuration may take place in the antrum. It is usually excited by the irritation of a carious molar tooth, or by some injury of the face, and may occasion much throbbing or lancinating pain. The pus, as it forms, will sometimes overflow, as it were, into the nose through the aperture into the middle fossa, and then may keep up constant irritation, with much fetor in the nostrils; in other cases, it drains through the socket of a tooth into the mouth; and in other instances again, its exit being prevented, it gives rise to enlargement of the cheek, the soft parts of which become brawny and inflamed, and the bones expanded, so that at last they are thinned to such an extent that, as in dropsy of the cavity, they crackle when pressed upon. Any portion of the wall of the cavity—the orbital, buccal, palatal, or nasal—may thus be expanded and fluctuation be felt through it; and, the lachrymal duct being commonly obstructed, the eye on the affected side becomes watery.

Treatment.—The treatment of this condition consists in the extraction of any carious tooth seated in the neighborhood of the antrum; or, if the teeth be all sound, in the removal of the second molar, the fangs of which come into close relation to, and frequently perforate the bottom of, the cavity. In this way an exit may be given to the matter; but as it will not discharge itself sufficiently freely, the antrum must be opened through the alveolus, or through the canine fossa under the cheek, provided it be much expanded in this situation, so that its cavity can be easily reached. The perforation into the antrum may readily be made, or the socket of the tooth enlarged, by means of a triangular antrum-perforator, such as here represented (Fig. 406). As the matter drains away, the cavity will gradually contract, and the deformity thus be removed. It is well not to attempt to perforate in the site of teeth that have been extracted for some length of time, as here the bone becomes unduly consolidated, and the attempt to reach the cavity is consequently likely to fail. The matter that is discharged is often very offensive, or it may be thick and pasty from the absorption of its watery parts. After the aperture has been made, the cavity should be syringed out with tepid water, and its shape gradually restored by pressure.

Tumors of various kinds spring from the upper jaw, taking their origin either from the surface of the superior maxillary or malar bones, from the interior of the antrum, or from the pterygo-maxillary fossa.

Fig. 406.

Triangular antrum-perforator.

Those that grow from the *surface of the bone*, are either some of the various forms of *epulis* that spring from its alveolar border, and must be treated as already described; or they are *exostoses* growing from the outer surface of the bone, projecting perhaps up into the orbit, and requiring removal with the saw, bone-nippers, or gouge. In doing this, care must be taken not to destroy the nasal process of the bone, lest the lachrymal sac be opened.

The tumors that spring from the *malar bone*, from the *cavity of the antrum*, or from *behind the upper jaw*, are of very various kinds; epitheliomatous, fibrous, recurring fibroid, cartilaginous, osseous, fatty, fibro-plastic, erectile, and encephaloid growths may all be met with in this situation. In the Museum of University College, which is very rich in specimens of these tumors, most of the above-named varieties will be found. The *fibrous tumor* is perhaps the most common; it principally occurs in elderly people, and may attain very considerable bulk. The *fibro-plastic* and *encephaloid* come next in order of frequency; and the *osseous*, *enchondromatous*, *epithelial*, and *myeloid* are extremely rare. The osseous tumors are remarkable as occasionally appearing to set up a spontaneous attempt at elimination, by necrosis taking place in them.

Situation and symptoms.—Epithelial, encephaloid, and myeloid tumors occasionally spring from the surface of the malar bone, pushing forward the cheek, spreading into the mouth, and involving, with greater or less rapidity, according to their malignancy, the soft structures of the face and the lymphatic glands under the jaw. They are usually rapid in growth, soft and elastic to the feel, irregular in outline, and only secondarily implicate the superior maxilla and neighboring cavities.

The various growths that are connected with, or spring from, the mucous membrane, or that develop within the antrum, in growing, gradually expand and dilate the walls of this cavity, pressing the bones outwards, thinning them, and giving rise to a considerable outward projection of one side of the face, the anterior surface of the superior maxilla being the part that usually first yields to the outward pressure. The tumor thus formed is usually smooth, round, or oval, slightly lobed perhaps, more especially if fibrous, and has in many cases a tendency to hang downwards so as to overlap the lower jaw to a certain extent. As it increases in size, it encroaches more or less upon the other cavities lying in the vicinity of the antrum. Thus, it pushes down the palate, causing considerable swelling in the roof of the mouth; displaces the alveolar process and teeth, giving rise to irregularity in their outline; and may encroach upon the orbit, occasioning stillicidium lachrymarum, or even impairment of vision. As the tumor enlarges, it obstructs the nasal cavity, and, stretching back into the pharynx, interferes with respiration and deglutition, and sometimes occasions severe epistaxis. When it is of an encephaloid character, obstruction of the nasal fossa will be found to be one of its earliest signs, leading to the suspicion of nasal polypus; but the true and more serious nature of the disease will be revealed by the integuments becoming involved, the gums implicated, and the submaxillary absorbent glands enlarged.

Diagnosis.—In the diagnosis of these tumors growing in the upper jaw there are three principal points to be attended to: 1, to distinguish them from fluid accumulations; 2, to determine whether the growth be simple or malignant; and, 3, to ascertain its primary seat.

1. In making the diagnosis from *fluid accumulation in the antrum*, the history of the case, and the uniform enlargement of the cavity without the tumor projecting externally beyond any part of its walls, the elasticity and even fluctuation that may, after a time, be detected, more particularly towards the outer side of the tumor, and at the junction of the mucous membrane of the cheek and the gum, will enable the surgeon to determine that it is not of a solid character. But in many cases this is not sufficient; and it becomes necessary to have recourse to an exploratory puncture by means of the perforator, through one or other of the more thinned and expanded parts already indicated. This should never be omitted in cases of doubt; for it has

happened even to so good a surgeon as Gensoul that, after making incisions through the cheek with the view of extirpating the tumor, the bones were found to be expanded by an antral abscess, and that, consequently, the operation had been undertaken unnecessarily.

[On the other hand, a solid growth originating from the posterior wall of the antrum may occlude its aperture, and thus secondarily give rise to an accumulation of fluid constituting a true dropsy of the antrum. Such a case has occurred in my own practice.—A.]

2. In determining whether the growth be of a *simple or a malignant* character, the surgeon will experience much difficulty, so long as it is confined to the cavity of the antrum; but, when once it has perforated and passed beyond its walls, this point is easily solved. Whilst the tumor is still confined within the antrum, much light may, however, be thrown upon its nature by attention to the rapidity of its growth; the greater this is, the more reason there is to suspect that it is malignant. Yet, though attention to this sign is of value, too much importance must not be attached to it; for though, as a general rule, fibrous and cartilaginous tumors may increase less rapidly than the malignant, yet it may happen that these attain a very great bulk in a short space of time. With regard to the age of the patient, that is of comparatively little value in a diagnostic point of view. I think, however, that, as a general rule, simple tumors most frequently occur in the young, whilst the malignant forms of the affection are commonly met with at the middle or advanced periods of life. It is of much importance, in a diagnostic point of view, to examine the condition of the submaxillary glands. When the disease is malignant, they become enlarged and indurated at a very early period. In a case under my care, the malignant character of a tumor, whilst still in the antrum, was determined by the fact of there being a long chain of indurated lymphatic glands lying under the angle of the lower jaw, where they had become secondarily affected by absorption, before the bones had been perforated by the growth. When once a malignant tumor has passed beyond the cavity of the antrum, and is thus relieved from the pressure of its walls, it grows with great rapidity, and where it can be felt under the skin is perceived to be soft and elastic. Insinuating itself extensively amongst the bones of the face and skull, it creeps through the foramina and fissures, and encroaches greatly on the nasal cavity and orbit; its early protusion into these cavities is especially characteristic of malignancy. It implicates the integuments of the cheek, with an inflammatory œdema, and the soft structures within the mouth, and throws out sprouting masses in these several situations, which present all the characters of the true malignant fungus.

3. A point of very great importance in relation to operative interference is to determine the *primary seat of the tumor;* whether it spring from the cavity of the antrum, from the malar bone, or from behind the superior maxilla in the spheno-maxillary or pterygo-maxillary fissure. When it springs from the interior of the antrum, the buccal, orbital, nasal, or palatal walls of that cavity are expanded, and the line of teeth is rendered irregular. When the tumor primarily springs from the *malar bone*, it pushes forward the cheek into a somewhat conical prominence, and dips down into the mouth between the gums and the soft structures of the face. It does not involve the orbit or palate, or alter the line of the teeth; but rather spreads over the bones, and involves the covering soft parts by continuity of tissue, without any definite anatomical disposition. As the tumor increases in size it will implicate the anterior wall of the antrum, and thus secondarily project into that cavity.

When the disease develops primarily *behind the superior maxilla*, between it and the great ala or the pterygoid process of the sphenoid, the upper jaw-bone will be found to be simply pushed bodily forwards, there being little if any deformity in its outline, the line of teeth not being displaced, nor the walls of the antrum—palatal, nasal, or orbital—expanded. Yet it must be borne in mind that the difficulty of diagnosis is greatly increased by the fact that a tumor, though not originating in the antrum, may pass into the orbit through the spheno-maxillary fissure, and may make its way forwards amongst the bones of the face, partly by creeping through, and partly by absorbing and displacing them.

Treatment.—In the treatment of tumor of the antrum, nothing can be done except to extirpate the growth; and it is consequently of great importance to distinguish those forms of the disease in which an operation can be undertaken with safety, and with a fair chance of success, from those in which none should be performed. When

the tumor, springing from the antrum, is of a simple character, the disease should be removed, together with the whole of the superior maxilla; the tumor, whatever size it has attained, being generally encysted, and the bones expanded around it; so that it is well bounded, and does not implicate the neighboring parts. Here, as Liston justly observes, no nibbling or grubbing operations should be done, but free excision of the whole mass practised. When the tumor springs from the spheno-maxillary or pterygo-maxillary fissure, pushing the bones of the side of the face forwards, an operation should not be lightly undertaken, as it is doubtful, in many cases, whether the surgeon can interfere with any prospect of success. Should, however, the tumor be of a simple character, the patient's health good, and an operation be deemed expedient, the tumor can only be reached by removing the upper jaw, when it may either be removed attached to that bone, or it may be extirpated from the cavity in which it lies behind it. Such an operation, implicating as it does the base of the skull, may be followed by death from shock to the nervous centres, as I saw happen in a patient of Liston's thus operated upon; or, involving as it does the internal maxillary artery, may be attended by very profuse and troublesome hemorrhage. [A similar unfortunate result followed in the case of a patient under my own care. A very large fibroid tumor involved the posterior wall of the antrum, encroaching upon that cavity and pressing the entire jaw downwards and outwards. Processes of the tumor extended upwards towards the base of the skull, backwards into the pharynx, and outwards, through the pterygo-maxillary fissure, into the cheek. The orbit was not involved, and the orbital plate of the superior maxillary bone was therefore allowed to remain; in spite of free hemorrhage the entire tumor was removed without much difficulty, but the patient sank shortly after the dressing of his wound, apparently from the commingled effects of shock and loss of blood. —A.] When once a malignant growth of this part has passed beyond the osseous boundaries of the antrum, implicating the soft structures of the cheek, with enlargement of the submaxillary glands, I do not think that it is wise or prudent to interfere with it by operation; as infiltration will have taken place more widely than the knife can reach, and speedy recurrence must of necessity ensue. So long as it is contained within this cavity, where indeed it is often impossible to ascertain, until after removal, the true nature of the affection, it may be excised, provided the glands in the neck be not greatly enlarged. If they be much implicated, even though the walls of the antrum be not perforated, I think it is safer not to interfere, as a cure by operative procedure must be hopeless. Whenever the soft structures of the cheek are involved so as to require partial excision with the tumor, no operation should be performed; as the disease will probably have become constitutional, cannot be completely extirpated, and will speedily recur in the cicatrix. When the upper jaw on both sides is affected, as sometimes, though rarely, has happened, it is clear that the tumor cannot be removed (Fig. 407).

Fig. 407.

Cancer of the upper jaw, involving the whole of the bones of the face; not admitting of operation.

Complete Excision of the Upper Jaw.—The operation of excision of the whole of the upper jaw, together with the malar bone on one side, for tumor of the antrum, was first proposed by Lizars in 1826; though Gensoul of Lyons was the first surgeon by whom the operation was actually performed, in May, 1829. This operation, though serious, is not very dangerous. Of 17 cases, collected by Hutchinson, in which it has been practised in the London hospitals, it was successful in 14; and of 16 cases (10 of total and 6 of partial resection) performed by Esmarch, 13 were successful (viz., 8 of the former and 5 of the latter). It may conveniently be done in the following way: The central incisor tooth on the diseased side having been extracted, the point of a bistoury should be entered opposite the external angular process of the frontal bone, and carried with a semicircular sweep into the angle of the mouth. From the upper end of this incision, a cut about one inch in length may be carried along the zygoma. Another incision is made from the nasal process of the superior maxillary bone, down to the side of the nose, round the ala,

which it detaches, and through the centre of the upper lip into the mouth. The flap thus formed is dissected upwards until the margin of the orbit is reached; the soft parts are then carefully separated from the floor of this cavity, and the infra-orbital nerve is dissected out and drawn upwards by a curved copper spatula, which protects it and the globe of the eye. The next step in the operation consists in the division of the bones. This may be best done with strong cutting pliers; the zygoma should be first cut across, the external orbital angle next divided, and then the internal angle cut through by putting one blade of the forceps into the nostril and the other into the orbit. The palatal arch must next be cut across by notching it deeply with a Hey's or a narrow-bladed saw, and then, passing the pliers into the mouth and nose, cutting through the line of the groove and the alveolus of the incisor that had been extracted. The whole mass having had its osseous connections separated, is depressed, drawn forwards, and readily removed by breaking down adhesions with the finger, or by the division of a few remaining soft parts with the bistoury. In the early stage of the operation, during the incisions through the cheek, there is often a good deal of hemorrhage; this may be arrested by pressure, or by the ligature of any vessels, such as the facial, or transverse facial, that bleed with great activity, and, if necessary, by the application of the actual cautery to the bones. However much the soft parts may have been stretched, no skin should ever be removed, as it will all eventually contract. In the latter stage of the operation, after the removal of the tumor, there is not so much hemorrhage as might be expected; though some branches of the internal maxillary artery will require ligature. By such an operation as this, the whole of the superior maxillary and malar bones may, if necessary, be removed, and the large cavity that is left between the eye and mouth, having some lint introduced into the bottom so as to support the parts in the orbit and the cheek, may be allowed to granulate; the cheek being replaced and retained *in situ* by a few points of twisted suture evenly introduced through the line of the incision in it, and in the upper lip. After cicatrization is complete, the deformity resulting from such a procedure will be far less than might at first be anticipated.

Partial excision of the superior maxilla.—In some cases, the malar bone and floor of the orbit will be found to be sound. When this is the case, they should both be left; and with this view, after the cheek has been turned up as just described, a deep groove should be made with a narrow straight-backed saw below the orbit, directly across from the nasal process of the maxillary and the outer edge of the malar bones. The removal of the growth may now be effected by cutting through the nasal process with the forceps, and then applying the instrument to the horizontal groove made below the orbit, after which the palatal arch may be divided as already directed.

Should the disease chiefly implicate the upper orbital and nasal portions of the bone, leaving the cheek and roof of the mouth sound, another modification of the operation may be undertaken by carrying the knife from the nasal process down the side of the nose and from the nostril across the cheek, dissecting up the flap thus formed, then applying a narrow-bladed saw from the anterior nares across the superior maxilla above its alveolar ridge, making a perpendicular cut from this into the orbit, and then applying the cutting-pliers along these lines of incision, cutting through the superior maxilla, and finally detaching it by dividing with the forceps the nasal process and the orbital plate.

Fergusson has in some cases succeeded in removing tumors of considerable magnitude by a single incision through the cheek, from the angle of the mouth upwards and outwards; and in other cases by slitting open the upper lip in the mesial line, and then carrying the knife along the side of the base of the columna into the nostrils; by which simple incision, this distinguished surgeon has shown, sufficient relaxation of parts can be obtained to excise the greater portion of the superior maxillary bone.

In order to reach and extirpate those tumors that lie behind the superior maxilla in the spheno-maxillary or spheno-palatine fissure, different procedures have been proposed and executed. Liston removed the superior maxilla and the tumor together. Michaux first removes the superior maxilla and then extirpates the tumor. Langenbeck has recommended laying open the face by carrying an incision from the angle of the mouth outwards and upwards to the zygoma, and then across the cheek under the orbit, applying the saw to the bones along this line, then turn-

ing the superior maxilla inwards towards the nose, with the soft structures of the face, removing the tumor that lies behind it, and then shutting down, over the gap that has been left, the cheek with the bone attached to it.

[This operation (known as *osteo-plastic resection*) would appear to be attended with even more risk than where the bones are absolutely removed—probably from affording less space for manipulation, and thus embarrassing the surgeon's movements. In Mr. Hewett's case the patient sank before the operation could be completed. (*Med.-Chir. Trans.*, vol. xxxiv. pp. 43–50.)—A.]

DISEASES OF THE LOWER JAW.

Tumors not unfrequently spring from the lower jaw. Like those in the superior maxilla, they may either be simple or malignant. Amongst the simple, we most commonly find the *fibro-cystic*. *Fibrous* tumors are also occasionally met with, and more rarely *osseous* and *enchondromatous* growths. The malignant tumors are principally of an *encephaloid* character. These various growths frequently occur in early and middle life, and usually spring from the diploe between the two tables of which the bone is composed. They project into the mouth and on the side of the neck, forming large rounded uniform, or imperfectly lobed masses. Occasionally malignant diseases spring from the neighborhood of the bone, and, without invading its structure, envelop it so as to give rise to an appearance of morbid implication of it.

In the *cystic* and *fibro-cystic tumors* of the jaw, the growth is expanded into cysts, having more or less solid matter intermixed, partaking of the character of epulis. These cysts are of various degrees of thickness; some being thin and membranous, others having the walls partly composed of fibrous tissue, and others again having expanded bony lamellæ largely entering into their composition, so that on pressure they occasionally communicate the semi-crepitant sensations peculiar to the cystic expansions of the osseous structure. The fluid contained in these cysts is a viscid liquid, usually semi-transparent, yellowish, or bloody.

Diagnosis.—In the lower, as in the upper jaw, it is of great importance to diagnose the simple from the malignant affections; as in the latter form of disease an operation is rarely justifiable, the soft tissues around the bone being usually implicated to such an extent as not to admit of removal, and consequently of the full and complete extirpation of the disease. The malignant tumors may generally be readily detected by the rapidity of their growth, by their pulpy or elastic character, and by infiltration of neighboring parts, with implication of the submaxillary glands.

Treatment.—The treatment of tumors of the lower jaw depends in a great measure upon the character of the growth. In cystic tumor of moderate size, with thin walls and but little deposit of fibrous tissue around the cysts, the best mode of treatment consists in cutting down on the expanded portion of bone, opening the cyst by means of the antrum-perforator, small trephine, or cutting pliers, according to its size and the thickness of its walls; letting out the fluid contained within; and then, by introducing a plug of lint, causing the cavity to granulate from the bottom, and gradually to contract. When the cysts are so large that they have destroyed the integrity of the bone, or when they are associated with a large quantity of fibrous tissue, so as to constitute true fibro-cystic tumors, excision of the diseased bone must be practised. This, also, is the only plan of treatment that can be had recourse to in other affections of this bone.

Excision of the Lower Jaw.—The operation of excision of a portion of the lower jaw for tumor of that bone was first performed by Deadrick of Tennessee, in 1810, and not, as is generally but erroneously supposed, by Dupuytren. As the growths for which this operation is performed are usually situated between the symphysis and the angle of the bone, seldom extending beyond the middle line, the operation is generally limited to one side of the face. In some instances, however, the tumor may encroach so far that it may be necessary to remove more than the half of the bone; and in other cases, again, though of very rare occurrence, the whole of the bone has been disarticulated.

When the tumor is of moderate size, and is situated about *midway between the symphysis and angle* of the jaw, it may be reached by making a semilunar incision of sufficient length under the lower edge of the bone, and carrying the anterior extremity of it well forward upon the chin, but not dividing, if possible, the lower

and carrying the knife cautiously along the inner side of the jaw, so as to detach the mucous membrane of the mouth and the mylo-hyoid muscle to a sufficient extent. In doing this the hemorrhage is often very profuse: the bleeding from the facial artery is particularly forcible, the blood being thrown in a larger and stronger jet than would seem probable from the size of the vessel. The hemorrhage should be at once controlled by the application of ligatures to both ends of the bleeding artery, and to any other points from which it is more than usually abundant. Unless this be done, the after-steps of the operation will be rendered much more obscure and difficult. One of the teeth on each side of the tumor having been previously drawn, the jaw must now be deeply notched through their alveoli into its base with a narrow strong-backed saw, and cut through with pliers, or completely divided with the saw. After the fragment of diseased bone, with the attached tumor, has been removed, and all bleeding vessels have been secured, the flap of cheek should be laid down smoothly, and retained *in situ* by means of hare-lip pins. Occasionally the dental artery in the cut jaw gives trouble; the hemorrhage from this source may be checked by the application of a piece of solid perchloride of iron. The patient must be fed with slops, which should be sucked in through a tube. At a later period, when cicatrization is well advanced, the teeth should be tied together with strong silver wire; or a silver cap should be fitted upon the teeth of the two portions of bone that are left, and attached by an elastic spring to another silver cap put on those of the upper jaw, so as to prevent the displacement that would otherwise occur in the smaller fragment. Union takes place after a time by fibrous tissue, which becomes sufficiently dense to make the jaw strong and useful.

In those cases in which the tumor *encroaches upon the angle and ramus* of the jaw, it is usually better to remove the bone at the articulation on the affected side; for, if the articular end including the coronoid process be left, it will be displaced forwards and upwards by the action of the temporal and external pterygoid muscles, and be a source of much inconvenience and irritation to the patient, unattended by any corresponding utility. In these cases, the removal of one lateral half of the jaw will consequently be required, and the operation may be performed in the following way. The point of a strong bistoury or scalpel should be entered immediately behind the articulation, carried down the posterior margin of the ramus behind the angle, and under the body of the bone beyond the anterior limits of the tumor, where it must slope gradually upwards, terminating at some distance from the lips, which should not be encroached upon; the convex flap thus formed is dissected up, and the facial artery and any other branches requiring ligature tied. The knife is then carried behind the jaw in front of the tumor, and, one of the incisor teeth having been extracted before the operation commenced, a saw should be applied to the bone in this situation, and its section finished by means of the cutting-pliers; the surgeon then dissects under and around it; in this situation a scalpel, curved on the flat, will be found useful, the edge of the knife being kept close to the bone and tumor. When he has cleared the tumor and ramus, he depresses the body of the bone forcibly with his left hand, in order more readily to divide the attachment of the temporal muscle to the coronoid process. This having been done, the only part left is the disarticulation, which is best effected by opening the joint from the front, whilst the bone is well depressed and twisted somewhat outwards, the edge of the knife being kept close to its neck, scraping the bone so as, if possible, to avoid wounding the internal maxillary artery, when, any remaining attachments having been cut through, the disarticulation is effected. In depressing the bone to reach the temporal muscle and the joint, care must be taken not to use too much force, lest it happen that the ramus give way, having been weakened by the disease; this accident would produce a good deal of trouble in removing the fragment left behind, which can only be done by seizing it with necrosis forceps, thus dragging it forwards, and then dividing the muscle and capsule. Should the internal maxillary artery have been divided, it must be ligatured, or the termination of the external carotid, where the vessel divides into the temporal and internal maxillary, tied: any other branches that bleed will necessarily also require the ligature. The cavity, having been lightly filled with lint, should then be left to granulate; the cheek being laid down and attached along the line of incision by hare-lip pins and twisted sutures. A kind of fibrous tissue forms in place of the jaw that has been removed, and comparatively little deformity results. When the disease of the bone extends *beyond*

the symphysis, a thick ligature should be passed through the end of the tongue, which must be drawn forwards by an assistant, lest, on the division of the insertion of its muscles into the lower jaw, it be forciby retracted into the pharynx, and thus threaten or even occasion suffocation, as has happened to surgeons of eminence both in France and in America.

For necrosis of the lower jaw, and the operations for it, see p. 858.

CHAPTER LVIII.

PLASTIC SURGERY OF THE FACE AND MOUTH.

By *plastic* or *reparative surgery* is meant the performance of operations for the repair of deficiencies in structure, whether resulting from injury, from disease, or from malformation.

It has been long known that partially detached portions of the body may retain their vitality sufficiently to become again adherent, when attached but by a very narrow tongue of tissue to the part from which they have been all but separated. This has often been observed in injuries of the face and fingers, portions of which have been nearly completely severed, and yet have united again on being replaced. But there are a sufficient number of cases on record to show that certain parts, when completely separated, may, after being replaced, again become adherent. The most remarkable instances of this kind are those which are related by Hoffacher, and attested by Chelius and Velpeau. Hoffacher was officially appointed to attend as surgeon at the duels which were at one time frequent amongst the students at Heidelberg; and as at these encounters broad-swords were used, he had an opportunity of seeing a considerable number of incised wounds, and has related no fewer than sixteen cases in which portions of the nose, lips, or chin had been sliced off, and, being put on again, contracted adhesions. Amongst the most remarkable of these, is one in which the end of the nose was sliced off by a cut with the broad-sword, and fell under a chest of drawers; it was not found for some time, but, on being recovered and washed, was stitched on, and became firmly attached. In another instance, a dog that was in the room snapped up the detached portion of the organ as it fell to the ground, but the nose, being immediately taken out of the animal's mouth and put on again, became firmly fixed!

In order that union should take place between parts that have been separated completely or nearly so, and the rest of the body, it is necessary that they be soft and vascular, and more especially that their structures be of a homogeneous character, such as is met with in the tissues of the face; where no very large bloodvessels, nerves, tendons, or bone are found. It is the same in plastic operations, which succeed best under similar conditions of tissue, and which are conducted on the same principle as an attempt at union in a partially severed structure.

It is principally for deformities and loss of the nose and lip that plastic operations are of much service; they may, however, occasionally be had recourse to in other situations, as about the cheeks and eyelids, but seldom with an equal amount of success. Reference has already been made (p. 414) to the performance of plastic operations on the perineum. In the practice of this very interesting branch of surgery, there is much opportunity for the display of manual dexterity. On this, indeed, almost the whole success of the operation depends; and a vast deal may be done in apparently the most unpromising cases by management, skill, and patience. In these operative procedures the names of Serres, Dieffenbach, Liston, Fergusson, Sédillot, B. Langenbeck, and Jobert, deservedly take the first rank.

In performing the various plastic operations, four methods have been employed. In the first, the flap of skin that is intended to repair the lost structure is transplanted from a distant part, as the arm. This operation, which was introduced by the Italian surgeon, Taliacotius, and hence commonly called by his name, has in a great measure fallen into disuse, on account of the difficulty of its execution, and the great uncertainty of obtaining a successful result. The second plan consists in

transplanting the reparative structure from some part in the neighborhood of the organ to be repaired; the skin from the forehead, for instance, being used for the formation of a new nose; that from the chin for the restoration of a lost lip. This procedure, which seems first to have been adopted by the natives of India in restoring the loss of the nose, is the method that is most commonly employed in this country in plastic operations on the face. The third method consists in loosening the skin by a process of subcutaneous section to some distance around the part to be repaired, and then drawing it forwards with or without incision through its substance. This gliding operation is chiefly practised for the closure of fistulous openings. The fourth method is employed in cases where an abnormal fissure exists in a part. It consists in bringing together and uniting the edges of the fissure, after having pared them evenly, so as to expose their vascular surfaces.

Union in plastic operations is affected by primary adhesion between the raw surfaces which are brought into contact. Should, however, this mode of union fail from any accidental circumstance, the surgeon need not despair; as the parts may unite by adhesive inflammation, or even through the medium of granulation, in a very satisfactory and complete manner.

For proper union to be effected, it is necessary that the edges be cleanly and evenly cut, so as to adjust themselves accurately to one another. This may often be most skilfully effected by making the incision in the part that is to receive the flap somewhat oblique or bevelled, thus securing a more accurate adaption of the edges.

After the flap has been formed and the part in which it is to be transplanted properly pared, the operation should be delayed a few minutes until all bleeding has ceased. This is of much importance, as the interposition of a layer of coagulated blood will materially interfere with union.

In bringing the parts into apposition, great care must be taken that no undue traction or constriction be exercised, lest their circulation be interfered with, and their vitality be endangered.

The parts may be maintained in apposition by sutures, collodion, or the application of a strip of isinglass plaster. The sutures should be as fine as possible, introduced with a small needle, and knotted on the sound parts. Occasionally, as in hare-lip, pins may advantageously be used. In some instances, instead of sutures, a small spring-forceps (Fig. 57), termed a *serrefine*, may be employed, but most generally interrupted sutures are the best. The use of collodion, where applicable, is of great advantage in plastic surgery, as it not only secures adhesion, but, by excluding the air, lessens the chance of suppuration.

For a plastic procedure to succeed, it is absolutely necessary that no morbid action be going on in the seat of operation; and not only that none be actually in progress, but that all have ceased for some considerable time. This is more particularly the case when the deformity for the remedying of which it is practised has resulted from syphilitic or cancerous ulceration. In both cases it is necessary to see that the constitution is sound, as well as that all local disease has been eradicated; otherwise the irritation of the operation might set it up again, and the new flap might be invaded and destroyed. From want of this precaution, I have more than once seen disappointment result. When an operation, as on the nose or lip, is performed for cancroid disease, ablation of the morbid part may be done at the moment of operating—the affection being a local one; when for struma or syphilis, the disease is constitutional, and care must be taken that all morbid action has thoroughly and completely ceased. As a general rule, plastic operations practised for the repair of mutilations from injury, or of congenital deficiencies, are more successful than those that are performed after disease.

No routine system of treatment should be adopted; but a few days of rest, good diet, and a dose or two of aperient medicine, may be prescribed before the operation is proceeded with. In the after-treatment of the case, a nourishing but unstimulating regimen should be observed.

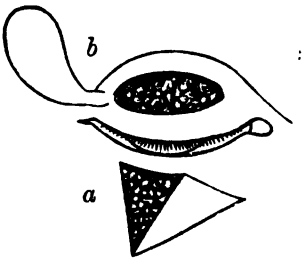
PLASTIC SURGERY OF THE EYELIDS.

Operations of various kinds are frequently performed on the eyelids, which are truly of a plastic character.

Blepharoplasty, or the operation by which the eyelids are repaired, is occasionally required for loss of substance—the result of wounds, cicatrices, or operations. It is less satisfactory in its results than most of the other plastic procedures about the face; yet it may, in some cases, improve materially the patient's appearance.

When the upper eyelid requires repair, the flap is taken from the forehead; when it is the lower lid, from the cheek or temple. This operation may be performed either by the gliding method, or by twisting a flap into its new situation. By the gliding method, a triangular flap is cut and partially detached (Fig. 408 *a*), and then drawn gently forwards until it corresponds to and fills up the gap that requires repair, when it is there fixed by a few points of suture. When the twisting method is employed, an oval flap is detached (Fig. 408 *b*), except its pedicle, and twisted down, to be planted on the raw surface.

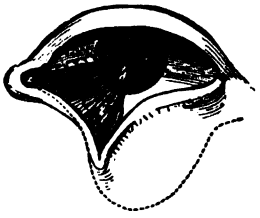
Fig. 408.



Operation for repair of eyelid: (*a*) gliding method; (*b*) twisting method.

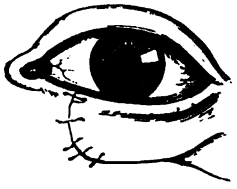
Occasionally neither of these methods is applicable; and then the procedure that I successfully adopted in a case of which the annexed cut (Fig. 409) is a representation, may be followed. In this case, which was that of a lady who had received a severe mutilation of the face by the explosion of a ginger-beer bottle, there was a deep and hard cicatrix across the lower eyelid, causing depression and eversion of

Fig. 409.



Lower eyelid deformed by cicatrix.

Fig. 410.



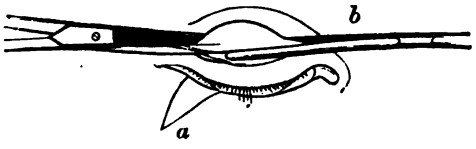
Lower eyelid after operation

its outer portion, and adhesion of the inner part to the ball of the eye. After dividing the adhesions and removing the cicatrix, I made a semilunar incision so as to dissect up the eyelid, and then fixed it by points of suture in its new situation, when it became firmly adherent (Fig. 410), and scarce any apparent deformity was left. In another very similar case, in which a girl had been bitten through the lower eyelid by a dog, a similar operation was practised with equally good results. In both these cases, the eyeball, having been injured, had become atrophied, with opacity of the cornea. But, when an artificial eye was adjusted to the shrunken globe, the appearance of the patient was most satisfactory.

Symblepharon.—In symblepharon, or adhesion between the lid and the eyeball, the adherent portion of lid may be included between V-shaped incisions and removed, and the edges of the cuts brought together (Fig. 411 *a*).

Epicanthis.—In epicanthis, or projection of the nasal fold of the eyelids, an elliptical portion may be removed parallel to the nose, and the edges of the incision brought together with sutures.

Fig. 411.



Operation for (*a*) symblepharon; (*b*) ptosis.

Ptosis.—In ptosis, or drooping of the upper eyelid, an oval portion of the lid may be raised horizontally, and removed so as to leave an oval gap (Fig. 411 *b*); the edges of which being brought together will lessen the depth of the lid, and thus diminish the deformity.

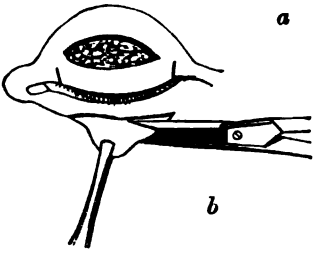
Entropium.—In entropium, or inversion of the eyelid, the same operation may be practised, and thus, by the contraction of the cicatrix, the tendency to its turning inwards lessened. But various other procedures are at times required in order

to remedy this deformity. Thus a vertical instead of a transverse flap may be removed; or Crampton's plan may be followed, which consists in making a vertical incision through the whole thickness of the lid, near each angle (Fig. 413 *a*), and then removing a transverse fold of the skin, and bringing the edges of the wound together in the usual way. This operation is chiefly applicable when the tarsal cartilage is contracted and, as it were, shortened. Lastly, when the tarsal cartilage is much contracted and inverted, the whole edge of the lid may be removed by passing a Beer's spatula between it and the ball, and cutting upon it.

Fig. 412.

Ectropium.

Fig. 413.



Operation for (*a*) entropium; (*b*) ectropium.

Ectropium.—In ectropium (Fig. 412), or eversion, the lid may be well everted, and a portion of the conjunctiva raised with a pair of forceps and snipped off, the contraction of the cicatrix drawing up the eyelid. This operation, however, seldom succeeds; and it is usually better to remove a wedge-shaped portion of the lid, of a size proportioned to the amount of eversion; or Dieffenbach's method may be tried, which consists in making a transverse incision through the lid down to the conjunctiva, seizing this, drawing it forwards until the lid is restored to its proper shape, then removing the projecting fold, and bringing the edges of the incision together in the usual way (Fig. 413 *b*).

PLASTIC SURGERY OF THE NOSE.

Rhinoplastic Operations occasionally require to be performed for the restoration of the form of the nasal organ, which has been destroyed by injury or disease. This branch of plastic surgery has long received much attention, and has been reduced to distinct rules. Either the entire nose, or a portion, may demand operation.

Columna.—When the columna and a portion of the septum are destroyed, a large gap is left at the nasal aperture; and, the nose becoming flattened in consequence of its tip falling in, great deformity necessarily results. The upper lip also, losing that amount of support which it receives from the columna, becomes pendulous, projecting, and thickened at the end, thus adding to the disfigurement. The restoration of the columna is effected from this thickened and prominent upper lip, which, by being reduced in size, is rendered far more shapely. The operation consists in cutting through the whole length of the lip from above downwards on each side of the mesial line, so as to leave a tongue about one-third of an inch in width. This is then turned up; and, its end being well pared, and the under surface of the tip of the nose properly vivified, it is fixed by means of a fine hare-lip pin and twisted suture, which should be left in for about four days. Union takes place in a few days; but, until this is firm, the new columna must be properly supported with narrow strips of plaster fixed to the cheek on each side. No twisting of this small flap is required, as the mucous surface speedily becomes cutaneous, and *vice versâ*. The division in the upper lip must be treated in the same way as an ordinary hare-lip, and unites without difficulty, lessening greatly the deformity in this part.

Ala.—When one ala only is deficient, the rest of the nose being sound, one of three processes may be adopted to remedy the deformity. 1. When a small portion only of the free border or of the tip has been lost, an incision should be made (Fig. 414) across the nose, and the remains of the ala and a portion of the nasal integu-

ment thus marked out dissected down, and attached to the end of the organ. In this way a very excellent result may be obtained.

2. If the loss of substance be greater, a flap of skin, of the proper shape to restore the deformity, may be raised from the cheek, applied to the previously pared edges of the part requiring it, and fixed there by a few points of fine suture.

3. If the loss of the substance of the ala be very considerable, or if it extend to a part of the body of the nose, then it is more efficiently restored by bringing a long narrow flap from the forehead in a way that will immediately be described. In the majority of cases, the destruction of the ala and of the body of the nose is so considerable, that other plans, to be presently described, are required for the repair of the deformity.

Fig. 414.

Deficiency of ala of nose.

Entire Nose.—For the restoration of the entire nose, two procedures have been employed: viz., 1, the Taliacotian operation; 2, the Indian operation.

1. The *Taliacotian operation* consists in taking the integument and areolar tissue required for the repair of the lost organ from the inside of the arm. Here a flap of sufficient extent is to be marked out and dissected up with its subjacent areolar tissue, leaving it merely attached to the limb by a root at its distal end. No attempt at fixing this flap to the nose should be made for at least a fortnight, during which time it should be kept upon a piece of wet lint, and allowed to thicken, granulate, and become vascular, so as to fit itself for adhesion to the new surface to which it is to be applied. The remains of the deformed nose having then been properly pared and the flap shaped, they must, after all bleeding has ceased, be properly adjusted and fixed to one another by points of suture. The arm must then be closely attached to the head, so as to be as nearly as possible immovable. At the end of about ten days, when adhesions have taken place, the connecting medium may be cut across, and the part left to be supported by the vitality which it may gain from the new surface to which it is now attached. This process is comparatively seldom had recourse to, for obvious reasons. The uncertainty of maintaining the vitality in the flap, the extreme tediousness of the prolonged constrained position in which it is necessary to keep the patient, and the great difficulty of guarding against movements of the arm, especially during sleep, and which, however slight and involuntary, would be sufficient to disturb union between the opposed surfaces, and occasion the failure of the operation, have caused this plan of procedure to fall into disuse; and it is now, I believe, universally abandoned by surgeons in this country, having been replaced by the more certain procedure, which will now be described, of borrowing the skin for the new nose from the forehead.

2. The *Indian operation*, a knowledge of which was brought to this country by Carpue, in 1814, is extremely successful in its results, though requiring a good deal of nicety for its proper execution. The operative procedures required by this method are somewhat complex, and may conveniently be divided into three distinct periods: 1, the dissection of the flap from the forehead, and its attachment to its new situation; 2, the separation of the root of the flap where it is turned down from the forehead, and the formation of a proper bridge to the nose; 3, the formation of the columna nasi.

1. *Formation and attachment of the flap.*—In the shaping of the flap, care must be taken that it is of sufficient size; as during the after-part of the treatment it often has a tendency to shrivel, and more inconvenience usually results from its not having originally been made large enough, than the reverse. The size adapted to the particular face may best be judged of by moulding a thin piece of gutta-percha to the nose, then flattening it out by dipping it in hot water, and using this as the guide for marking the outline of the flap upon the forehead. This should be traced with tincture of iodine, which will not be washed off so readily as ink by the flow of blood, which is often rather free. This flap should be of the shape in Fig. 415, taking care that it is rather square at the angles, and not too much rounded off. The size will necessarily vary according to the character of the countenance, and the extent of loss that has to be repaired. When the whole of the nose requires restoration, it is usually necessary to make it about two and a half to three inches in length, by about the same in width at the broadest part. It may either be taken from the

Fig. 415.

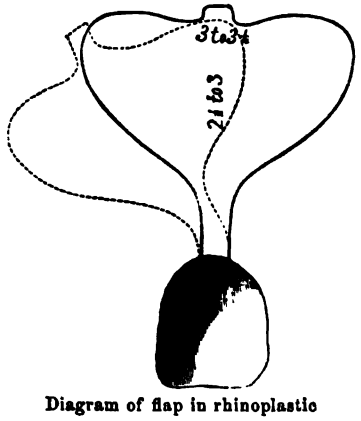


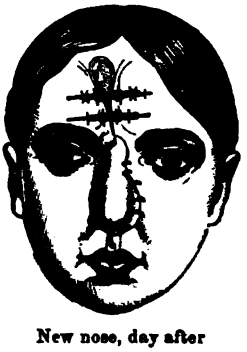
Diagram of flap in rhinoplastic operation.

middle of the forehead, or obliquely from one side; if the latter, the right side is most convenient. It must now be dissected off the forehead; in doing this, care must be taken to cut the flap as thick as possible, especially at its root between the eyebrows. It must also be but little handled, and, above all, not pinched, either with fingers or forceps. The dissection should be commenced at the root, so that the outline may not be obscured by blood; and this part should be left long, in order to admit afterwards of a very gradual and easy twist. In order to facilitate this, it is also desirable to make the incision on the right side a little lower than that on the left. After the flap has been raised throughout the whole of its extent, a piece of wet lint should be applied to the forehead, with a view of arresting the bleeding, before the next step is taken. This consists in paring the surface and edges of the stump of the nose, and removing the integuments from it in such a way as to leave a triangular raw surface. In doing this care must be taken—whilst a good base of attachment is left—not to remove the parts too widely, lest the cheeks, by separating, have a tendency to gape too much, and the nose to become flattened out. The integuments also should be dissected away in such a manner as to form a deep groove shelving inwards, so as to receive and hold the flap more securely and with less overlapping of the edges. The operation must now be discontinued for a few minutes until all bleeding has ceased, and the cut surfaces have become glazed; this point is of great importance in securing direct adhesion, and must be carefully attended to. The bleeding having been arrested by exposure to the air, and by the torsion rather than the ligature of any spouting branch, the flap from the forehead should be brought down by a twist from left to right, and attached by a few points of fine suture on each side to the edge of the incision, around the nasal aperture. A pledget of soft lint, moderately greased, should now be gently insinuated under the flap, the lower part of the incision in the forehead drawn together by a point of suture, but not so as to constrict the root in any way, and the rest of the exposed surface covered with water-dressing. The parts will then present the appearance of Fig. 417, taken from a patient of mine the day after the operation. Fig. 416 represents the deformity for which the operation was performed. The patient should be put to bed with a piece of soft lint laid over the whole of the face, so as to maintain its temperature; and, if it be winter, he must be placed in a room that is kept well warm day and night. The diet for the first few days should be simple, but abundant, consisting chiefly of nutritious slops.

Fig. 416.

Depressed nose.

Fig. 417.



New nose, day after operation.

The dressings must not be disturbed for three days; by this time, if all go well, the flap will be found somewhat tumid, warm, and sensitive, but pale in color. The plug in the nose will now require changing, lest it be rendered offensive by the discharges; its withdrawal and the substitution of another must be done with the greatest gentleness, the surgeon bearing in mind that any undue pressure or traction may destroy adhesions, and prove fatal to the vitality of the flap. If the sutures produce no irritation, they may be left in till the fifth or sixth day, by which time the adhesions will be tolerably perfect, and they may with safety be cut and withdrawn. As the adhesions strengthen and the vitality of the flap improves, it must be elevated by putting underneath it a larger plug of lint; for which, after a time, may be substituted a small gutta-percha tube moulded to the figure of the inside of the nose. Œdema of a somewhat solid character is apt to come on in the flap, giving it a white appearance; but this is of little moment, and will gradually subside as

the circulation through it becomes more actively established. The flap gradually becomes thicker and firmer, throwing out granulations from its under surface, which eventually becomes clothed with mucous membrane. The wound in the forehead must be dressed like an ordinary ulcer, and be well touched with nitrate of silver from time to time, to insure its contraction. It usually cicatrizes with great readiness, and leaves remarkably little deformity.

2. *Separation of the root of the flap.*—This may be done about a month after the flap has been fashioned, when its vascularity, through its lateral adhesions, will be perfected. The division of the root is best done by passing a narrow-bladed bistoury under the twist, and cutting upwards towards the eyebrows, removing a wedge-shaped portion of the soft parts, so as to make a smooth and proper bridge.

3. *Formation of the columna nasi.*—The addition of the columna is now all that is wanted to make the nose complete. This must be made from the upper lip, perhaps at the same time when the bridge is fashioned; and it may be cut and fixed in the way that has been already described in speaking of the restoration of this feature, the interior of the apex of the new nose having been well pared to receive it. The columna requires to be well supported by means of a narrow strip of plaster passing from one cheek to the other, and usually requires a good deal of fashioning before it is perfect; indeed, this is the part of the operation that I have found always most troublesome, and requiring most attention.

The new nose must continue to be supported from beneath, for some months after its formation, by plugs of lint or small gutta-percha tubes, as it will evince a great tendency to contract and to alter in its general outline and shape; becoming, if the surgeon be not careful, either depressed or dumpy. The sensibility of the new nose is entirely destroyed for a time after the division of the bridge; but it slowly returns from all sides, appearing first in the neighborhood of the adhesions between it and the cheeks, then near the columna, next in the bridge, and thus the organ at last has its sensation restored; for this, however, several months will usually be required, and the part in which it returns last of all is its central portion. The

Fig. 418.

Patient before rhinoplastic operation.

Fig. 419.

Same patient some months after operation.

annexed cuts (418, 419) give a very faithful representation of a patient on whom I operated, before and after the restoration of the lost organ.

The success of the case will depend very greatly upon the minute attention which the surgeon bestows on the details of the operation, and on the care which he takes in the after-treatment. During the operation, the chief points to be attended to are, that the flap be made of sufficient size, that all oozing have ceased before the cut edges are brought into contact, and that no tension nor constriction be exercised. A principal source of failure in the operation, or in the result so far as concerns the after-appearance of the patient, is gangrene of the flap, in whole or in part, arising from the root being too narrow or too tightly twisted, or from the flap being too roughly handled in its dissection. So also, if it be cut too small and not properly supported afterwards, the result will not be very satisfactory. Other accidents occa-

flap, or coming on at a later period, and causing the new nose to slough under the attack of inflammation, which it has not sufficient vitality to resist, as happened in one of Liston's earlier cases; or the new nose may be destroyed by a return of the lupus which proved destructive to the old one. Hemorrhage may also occur from underneath the flap. In the last case operated on by Liston just before his death, and which was completed by Morton at University College Hospital, hemorrhage to the extent of more than a pint took place on the ninth day, without any evident cause, from under the flap, and could only be arrested by plugging. Further, the operation is not without its dangers. Dieffenbach lost two patients out of six on whom he operated in Paris; their constitutions probably having been in an unfavorable state.

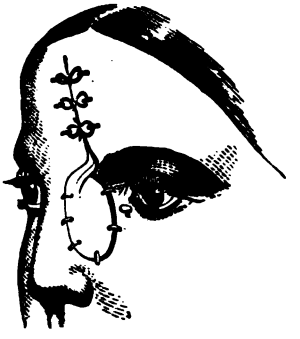
The operation as just described will usually be attended by very satisfactory results. Of late years some modifications have been introduced into it. Thus Langenbeck recommends that the periosteum should be dissected up from the frontal bone together with the skin-flap, in order that, by the after-development of osseous tissue, a firmer and better organ should be left. It has been feared by some surgeons that the exposure of the frontal bone, by stripping off its periosteum, would probably be followed by necrosis. Experience has, however, shown that this fear is groundless, as, indeed, might have been inferred from analogous conditions often observed in injuries of the head, in which large portions of the pericranium may be detached without the exposed bone losing its vitality. [In Dr. Bigelow's case, however, while no new bone was developed in the nose, the denuded portion of the frontal bone did necrose and eventually exfoliated.—A.] But it appears to me that there are more serious objections to "Osteo-rhinoplasty," and that it is an unnecessary complication of the operation to turn down the pericranium in the nasal flap, for two reasons. First, the pericranium is very firmly attached to the bone, and very loosely to the integumental structures, which glide over it. From the bone it is not detached without difficulty and the necessity of a certain degree of scraping, by which its vitality is not unlikely to be impaired to so great a degree that it would be of no service as a bone-producing organ in the new nose, and would not improbably slough away when twisted down from insufficient vascular supply. Secondly, even if the pericranial lining of the new nose were to retain its bone-producing power, it seems to me that an osseous layer inside that organ would rather be a disadvantage than of service, and would certainly expose it to a greater risk of fracture, and other injury than if such brittle material as a thin shell of bone did not enter into its composition.

The operation practised by Ollier appears to me to be less happy than many of

Fig. 420.

Opening into anterior nares.

Fig. 421.



Opening into anterior nares closed by operation.

that excellent surgeon's suggestions. It consists in cutting down the nasal process of the superior maxilla, and then bending it across so as to form a kind of

bridge, on which to sustain the integumento-pericranial flap deflected from the forehead. But by doing this the lateral supports to the bridge of the new nose are removed, and necrosis of the bent or rather broken fragment of bone, which has actually occurred, is not an unlikely accident.

Fistulous Openings through the Nasal Bones leading into the interior of the nostrils are occasionally met with. Such apertures as these are, perhaps, best closed by paring the edges, and then bringing forward a flap of neighboring skin by the gliding operation. In some cases of this kind, procedures may be required, in which the surgeon may display much ingenuity and benefit his patient greatly. The cuts represent a case many years since under my care, before and the day after operation, in which a large aperture into the side of the nose, resulting from necrosis of the left nasal bone consequent on scarlatina (Fig. 420), was successfully closed by a flap of skin taken from the forehead by the twisting process (Fig. 421). The patient, who was a child at the time of the operation, has now grown into a comely young woman, presenting scarcely a trace of the operation.

Operation for Depressed Nose.—Sometimes the nose is depressed and flattened in consequence of the loss of the cartilages, vomer, and septum, though the external parts remain entire. Dieffenbach has proposed a plan for raising it by slitting it longitudinally into three pieces; dissecting the lateral slips from the osseous attachments; paring the edges to such an extent that they overlap, and stitching them together; then bringing the whole organ forwards by pushing long hare-lip pins across its base, so as to elevate and narrow its attachments, which are brought more into the mesial line. Fergusson has improved this procedure by not slitting the nose down, but dissecting it away from the bones from within the nostril, and then pushing long steel-pointed silver needles across from cheek to cheek, and twisting their ends over perforated pieces of sole-leather, through which they had previously been passed, thus bringing the whole organ bodily forwards. The columna is next fashioned in the way which has already been described; and the nose is completed.

PLASTIC SURGERY OF THE LIP.

Hare-Lip.—By hare-lip is meant a congenital perpendicular fissure or fissures through the upper lip, the result of an arrest of development. The condition thus produced in man is, according to Geoffroy St. Hilaire, not analogous to what is met with in the hare, but to that which occurs in animals of a lower grade of organization—in fishes. The arrest of development takes place opposite the line of junction between the intermaxillary and superior maxillary bones, and is usually associated

Fig. 422.

Single hare-lip.

Fig. 423.

Ordinary double hare-lip.

Fig. 424.

Ordinary double hare-lip. Side view.

with a certain amount of disunion or malformation at the line of junction between these bones. When the arrest of development takes place on one side only, the hare-lip is said to be *single* (Fig. 422). In it the mesial side of the gap is usually rounded; the outer edge is flattened; and the frænum at the angle is long and subcutaneous. It most frequently, so far as I have observed, occurs upon the left side. Not unfrequently there is a fissure on each side of the mesial line; and then the hare-lip is said to be *double* (Figs. 423,

424). When double, the fissure is deeper on one side than on the other, and usually extends into the nostril, and is associated with cleft palate; though sometimes it stops short of this. In these cases the nose is usually flattened and expanded, and between the fissures there is always a central or median lobule, consisting of the intermaxillary bones in a rudimentary condition; to this a triangular labial nodule is commonly attached. In many cases this is pushed forwards, and tilted on its base, so that the alveolar border projects forwards. Sometimes the projection is so considerable that it is attached to the tip of the nose.

Median fissure is so rare that there are scarcely any authentic cases of it in the records of surgery. Delahaye, however, mentions one instance of mesial fissure of the upper lip with two lateral fissures, and Nicati has described one in the lower lip, the only case of the kind that I have met with on record.

The cleft in hare-lip corresponds to the line of junction between the embryonic intermaxillary bones and the superior maxilla. The fissure, when single, may be confined to the lip; but in the majority of cases it extends to the alveolus of the upper jaw, giving rise to a deep notch between the outer incisor and the canine tooth. When double, the four incisors, usually imperfectly and irregularly developed, are included in the central intermaxillary tubercle. Meckel and Nicati have described a rare form of hare-lip, in which the fissure corresponds to the line of junction between the central and lateral incisors. In many cases the fissure extends back into the palate; this more frequently happens when the hare-lip is double, and in these cases every variety of palatal deformity is met with (Fig. 425).

Fig. 425.

Jaw in double hare-lip, and cleft palate.

Age for operation.—The cure of hare-lip can only be effected by a properly conducted operation. In the performance of this, the first point that has to be determined is the age at which it should be done. On this there has been, and is still, a good deal of difference of opinion. Surgeons generally are, however, I think, agreed that it is better not to perform the operation during dentition; at all events not during the cutting of the incisor teeth, when there is much local excitement and general irritability of the nervous system; but they are not agreed as to whether it should be done before or after dentition. In support of the opinion that it is more prudent to wait until after this period, it is alleged that very young infants are especially liable to convulsions; that the performance of operations on them is troublesome; and that it interferes with suckling. These statements, however, are not carried out by what we meet with in practice. I think there is no evidence to show that there is any danger in operating during early infancy; indeed, I believe that very young children, those but a few weeks or months old, bear operations remarkably well. I have repeatedly operated at these tender ages, not only for hare-lip, but for hernia, the removal of tumors and nævi, the division of tendons, &c., and have never seen any bad result follow. Besides this, the performance of the operation is easier at a very early age than when the child has reached its first or second year; when, its intelligence being more developed, it knows what it has to suffer, and screams and struggles more than a very young infant does, whenever it sees the surgeon, or when he makes an attempt to examine the wound or dressings. After the operation also, the child will, when young, take to the breast without difficulty and with the greatest avidity. The act of suction is advantageous, as in it the sides of the incision are more closely compressed and brought together. At very early ages, union of the wound takes place with great readiness and solidity; and, as no time has been given for the rest of the features to become distorted, there will not be that permanent flattening and deformity of the face which is apt to continue after the hare-lip is cured, if the operation be deferred to a more advanced age. For these various reasons I agree with Dubois, Fergusson, and Butcher, that the operation had best be performed early; if possible, at about the sixth week after birth, or from that to the third month, which may, I think, be considered the time of election for this procedure. At this time the vitality of the child is good, and the tissues are not so lacerable as at an earlier age. Should circumstances require it, however, the operation might be done at a much earlier period than this. Thus, at the urgent solicitations of the parents, I have performed it within the first

twenty-four hours after birth, and several times during the first week. But in these early days of life the operation is not without danger; the vitality of the child is often feeble, it suffers greatly from the loss of even a very small quantity of blood, and the tissues are so lacerable that there is great danger of the pins or stitches cutting out. I would therefore not advise its performance then.

It is scarcely necessary to observe that, as union by the first intention is aimed at, the operation should not be undertaken unless the health be good; and certainly not if the child, at whatever age, have but recently recovered from measles, scarlet fever, or other infantile disease.

Operation for Hare-lip.—In the treatment of hare-lip, there are three main objects to be kept in view: 1. The procuring of union by the direct adhesion of the cut edges of the fissure; 2. The prevention, as far as possible, of deformity during the process of union; and 3. The avoidance of all traction on the line of incision that may interfere with these results.

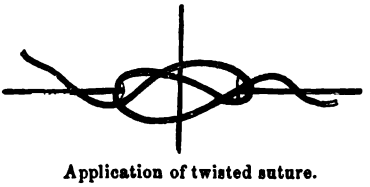
These principles of treatment are carried out by paring the edges of the fissure freely, bringing them together by means of the twisted or interrupted suture, and taking off all tension by means of strips of plaster and the cheek-compressor. But the details of the treatment vary so much, according as the fissure is single or double or complicated by more or less projection of the intermaxillary portions, that the steps of each operation require to be separately described.

Single hare-lip.—The operation for single hare-lip is performed in the following way. The child having been well pinned in a jack-towel that swathes it tightly, the surgeon, sitting down, places his feet on a stool so as to raise them; and, covering his knees with a piece of tarpaulin, holds the child's head firmly between them. He first freely divides the frænum and all membranous connections between the angle of the cleft and the gum of the upper jaw, and then, putting the lip on the stretch by seizing the extreme edge of the cleft with a pair of artery-forceps or a tenaculum, pares the edges of the cleft by transfixion with a narrow-bladed bistoury, or fine scalpel, from above downwards, first on one side, then on the other; taking care that the incisions unite neatly and cleanly above the upper angle of the fissure, which must be well cut out; and that they extend sufficiently far outwards to cut away the rounded portion of the prolabium which forms the side of the base of the fissure. Care should be taken that enough is cut away; there is more danger usually of taking too little than too much.

In single hare-lip, where the lips are very lax, the incisions may be straight; but if the gap be wide and the tissue deficient, or in double hare-lip, they should be somewhat concave inwards: in this way there is less likelihood of an unseemly notch being left (Fig. 428).

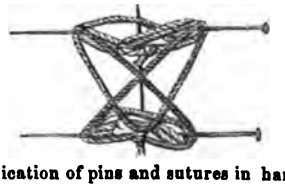
Fine hare-lip pins, made of soft iron wire, with steel points, should then be deeply introduced through the lip from one side of the fissure to the other. The pins should be entered at about a quarter of an inch from the pared edge on one side, and brought out at a corresponding point on the other; care being taken that, though they are passed deeply, the mucous membrane is not transfixed: if it be, it will be doubled into the wound, and thus interfere with union. Two pins are usually required; if the child be some years old, and the fissure very long, three may be used. The lower pin should be introduced first underneath or through the cut labial artery, in such a way that its pressure may stop the bleeding from this vessel, which is often rather free: in passing this pin, great care should be taken to bring the opposite

Fig. 426.



Application of twisted suture.

Fig. 427.



Application of pins and sutures in hare-lip.

sides of the fissure well into contact, so as to be on a level below, that no irregularity may be left in the prolabium. The twisted suture is then applied in the usual way (Fig. 426), first round the lower pin, and then round the upper one (separate

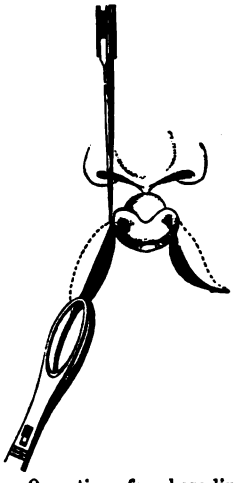
threads, however, being used for each); and lastly, the two are united by a few cross turns so as to press down and support the whole length of the fissure (Fig. 427.) In applying the twisted suture, the surgeon must be careful, whilst drawing the edges closely into apposition, not to apply the threads too tightly, lest sloughing result; and in crossing them from one pin to the other, great caution must be used not to draw the two pins together horizontally, lest puckering of the line of union take place. The pins are then cut short, the whole is coated with a layer of collodion, and a piece of plaster is put under the ends of the pins to prevent excoriation of the skin. In addition to the pins and twisted suture, I invariably introduce one point of interrupted suture through the mucous membrance of the lower part of the fissure, just inside the mouth; and I look upon this as of great consequence in order to prevent the notching, which is otherwise very apt to occur, in consequence of that portion of the incision between the lower pin and the edge of the lip being kept open by the child in sucking, or protruding its tongue against it. At the end of from 72 to 96 hours, according to the age of the child, the pin should be withdrawn, or may be removed by pushing it through the lip by a gentle rotatory movement, in such a way that the cut end does not tear or lacerate the aperture in the lip. The threads, matted together with exudation and a little blood, form a good crust, which may be left on for two or three days longer, and then allowed to separate of itself; the less any crusts that form over the line of incision are interfered with, the better will usually be the result. The lip may, if thought desirable, be supported by a strip of adhesive plaster, which should, indeed, be continued for about a fortnight after the operation, so as to prevent stretching of the cicatrix and notching of its lower part. The point of interrupted suture may be left in for about four days. It sometimes, though rarely, happens in single hare-lip that the intermaxillary portion is so large and projecting, that there is difficulty in bringing the lateral segments together over it. Should this be the case, the better plan is to notch it at its alveolar border on the side that is not fissured, and then to break it back so as to remove all projection. If the fissure be wide, and the child restless, so that there is danger of the parts being dragged upon during its screaming or crying, it is a very good plan to apply the spring cheek-compressor, invented by Hainsby, here represented slack (Fig. 428). Indeed, whenever obtainable, this excellent contrivance should be employed. Its use adds greatly to the success of the operation.

Fig. 428.

Hare-lip: spring cheek-compressor.

Double hare-lip.—The operation for double hare-lip is performed on the same principle as that for the single form of the disease, viz., of procuring union by adhesion between the opposite surfaces. The difference in the operations consists chiefly in dealing with the intermediate portion of the lip and alveolus (Fig. 429). The management of the intermaxillary process must vary according to its size and degree of projection. If it be small and rudimentary, or fixed to the tip of the nose, as in Fig. 430, it should be cut off with bone-nippers, as it would prevent the lateral segments from coming into proper apposition. Most commonly, when this is done, there is free and even dangerous bleeding from a dental artery deep in the bone, which may require to be touched with a red-hot needle or wire before the hemorrhage from it will cease. If the central intermaxillary portion be large and projecting, it should be bent or broken back by strong forceps covered with vulcanized India-rubber. If it be large and not projecting, the soft parts should be well pared on each side, and transfixed by the hare-lip pins, and thus be interposed between and united to the pared lateral surfaces; indeed, it is always advisable not to remove this, unless it be awkwardly situated, as in Fig. 431. When it is left, though the union may not appear quite so perfect and uniform as it would if the lateral halves had been directly united, yet eventually the case will turn out better; the central portion becoming developed, and forming the natural mesial projection of the lip, which is lost when the lateral halves are directly united. Butcher has invented some very simple and ingenious forceps for the partial section and bending back of the intermaxillary process. In some of these cases great nicety is required in planning the incisions, and in the introduction of the sutures. The

Fig. 429.



Operation for hare-lip. Right side of lip drawn down by spring-hook forceps; long narrow knife entered at angle; dotted line shows direction of the incision.

Fig. 430.

Double hare-lip: intermaxillary portion fixed to nose.

Fig. 431.

Double hare-lip; projecting intermaxillary portion.

central portion is most advantageously pared in a somewhat concave manner, so that the freshly-cut edges of the lateral halves are received into and more accurately fitted upon it. Should, as often happens in single as well as in double hare-lip, one of the lateral segments be tied down to the gum and alveolus by a doubling of mucous membrane, this must be freely divided, and the portion of lip, with perhaps the corresponding ala of the nose, freely dissected up from the osseous structures, so as to admit of its being moved forwards without too much traction being put upon it.

Treatment by simple suture.—During several years I have been in the habit of treating hare-lip of all kinds, double as well as single, with the simple interrupted suture alone, without using any pins. I have in this way treated most successfully many cases in children, whose ages have varied from a few days to four years, with most satisfactory results, and with less marking of the lip than I have ever seen attend union by means of the twisted suture, to which I now generally prefer the simple suture as being equally safe, more simple, and followed by less scarring of the lip, provided the case be not too complicated, nor associated with very wide fissure in the palate, or with great projection of the intermaxillary bones. In these circumstances, the pins should be preferred.

When the fissure is single, the edges, having been pared in the usual way, should be brought together by two points of suture; the first passed deeply near the free edge, and in such a way as to compress the cut coronary artery; the other nearer the nasal angle. These sutures should be of thick well-waxed dentist's twist, that will not cut out too readily, or, what is better, of silver wire. A point of fine interrupted suture should then be inserted through the mucous membrane inside the lip. The lip may then be supported by two narrow strips of plaster, one placed between the sutures, the other between the upper suture and the nose. On the third day the upper suture should be taken out, but the lower one may be left in for a day or two longer, when it and the one through the mucous membrane may be removed together, unless the latter have already cut its way out. If silver wire sutures are used, they may be left in for six or seven days without producing irritation. The lip must then be supported for a few days with a strip of plaster.

In the case of double hare-lip the same plan is to be adopted, first on one side, then on the other; but here, as the gaps are wider, and the tension, more particularly when the intermaxillary prominence is very projecting, is apt to be considerable, it is necessary to support the cheeks, and thus to prevent undue traction on the stitches, by means of the cheek-compressor. In this way all risk of the stitches cutting out before union is completed is avoided; and excellent and solid union will speedily be obtained even in cases of double hare-lip, with some intermaxillary projection and fissured palate.

The operation occasionally fails. The probability of the occurrence of such an untoward event is, however, greatly diminished by the use of the cheek-compressor. It may, however, happen either in consequence of the child's health being in an unsatisfactory state, so as to prevent union by the first intention; or in con-

sequence of the pins having been withdrawn too early, before secure cohesion has been effected. In such circumstances as these, an attempt might be made to unite the granulating edges by the reintroduction of the pins or sutures, and by firmly fixing the lip by means of the cheek-compressor. Such attempts, however, rarely succeed: should they not do so, it will usually be found most prudent to wait at least a month before taking any further steps, and then to pare the edges afresh and repeat the original operation.

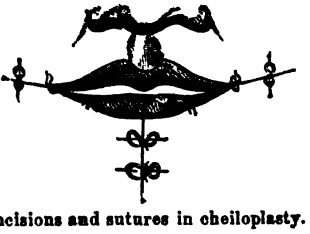
Congenital Transverse Fissures of the Cheeks, extending from the angle of the mouth to the anterior border of the masseter or up towards the malar bone, are occasionally met with, and have been specially described by Klein and Nicati. Such malformations require to be treated on exactly the same principles, and with the same attention to details, as hare-lip; union between the pared edges being effected by means of hare-lip pins and the twisted suture.

Cheiloplasty.—Simple plastic operations are commonly practised on the lower lip for the removal of cancroid disease, by cutting out a V-shaped piece of the lip, including the whole diseased structure, and then bringing together the opposite sides of the incision by hare-lip pins. These operations have already been described and figured at page 877. We shall consider here those cases in which it becomes necessary to repair more or less extensive loss of substance in the labial structures. The restoration of a portion of the lip that has been destroyed by accident or disease, is not so readily effected as that of the nose; yet a good deal may be done to remove the deformity. The plan originally introduced by Chopart consists, when it is the lower lip that is deformed, in carrying an incision from behind the lower jaw down to the hyoid bone, so that a square flap may result, which is detached from above downwards. This flap is then brought up, and fixed to the pared edges of the remaining portion of the lip by points of suture; the head being kept properly inclined, in order to prevent undue tension. After sufficient union has taken place to preserve the vitality of the flap, its lower attachment may be divided. The flap should, if possible, not be twisted, though it is not always practicable to avoid this. This operation is not usually very satisfactory in its results, as the new flap is apt to become œdematous and inverted at the edge, or the flow of saliva may interfere with proper union. In those cases in which the greater portion of the lower lip has been excised for cancerous disease affecting its upper margin, the most successful procedure for the restoration of the deformity consists in a modification of the plan recommended by Serres; and from this I have derived excellent results, as in the case which is here represented (Fig. 432). The object of the operation is to raise the lower lip to a level with the incisor teeth. An incision, about three-quarters of an inch in length, is made directly outwards from the angle of the mouth, on each side, into the cheek; from the extremity of this, a cut is carried obliquely down-

Fig. 432.

Lines of incision in cheiloplasty.

Fig. 433.



Incisions and sutures in cheiloplasty.

wards on to the upper margin of the lower lip, so as to excise the included triangular piece; the lower lip is then dissected away from the jaw, from the inside of the mouth, and a V-shaped piece is taken out of its centre. By means of a hare-lip pin on each side, and a point of suture, the incisions in the angle of the mouth are brought accurately together; and in the same way the vertical one, in the centre, is united (Fig. 433). In this way the whole of the lower lip is raised, and brought more forwards. If care have been taken, in removing the cancer from the edge of the lip, to leave the mucous membrane rather long (which may always be done, as the skin is affected to a greater extent than it), a good prolabium may be formed, and the restoration effected with but little deformity. Care must be taken to prevent union from occurring between the inside of the lower lip and the gum, by the interposition of a strip of oiled lint.

Buchanan, of Glasgow, as far back as 1841 published an account of a method for restoring the lower lip when affected by extensive cancerous disease, which leaves most satisfactory results. The accompanying figures illustrate the kind of case in which Buchanan's operation is applicable, the lines of incision required, and the appearance presented by the chin and lip after the disease has been removed, and the flaps brought into proper apposition.

The steps of the operation are simple, and the result is excellent.

The diseased part of the lower lip is first removed by an elliptical incision (Fig. 434, A B A). An incision, B C, is then carried downwards and outwards on each side to the chin; and another incision, C D, upwards and outwards parallel to, and corresponding in length to, A B. The flaps formed by these incisions are represented in Fig. 435. They are detached from their subjacent connections; and the

Fig. 434. Fig. 435. Fig. 436.

Buchanan's operation for the restoration of the lower lip.

whole is raised upwards, so that the original elliptical incision comes into a horizontal line, and is made to constitute the margin of the new lip; the secondary incisions under the jaw coming together in a vertical direction, in which they are retained by twisted and interrupted sutures (Fig. 436).

PLASTIC SURGERY OF THE PALATE.

Various degrees of congenital deformity may occur in the palate and uvula: thus the uvula alone may be bifid, or the cleft may extend through the greater part of the whole of the soft palate; or the hard palate may be divided as well (Fig. 437); and, lastly, the separation may extend forwards to the integuments of the face, producing single or double hare-lip. The soft palate and uvula are not unfrequently cleft without the hard palate being divided; and, in some very rare cases, the lip and the hard palate are fissured without the soft one being cleft.

Fig. 437.

Fissure of hard and soft palate.

These malformations necessarily give rise to great inconvenience, by interfering with deglutition, and rendering speech nasal and imperfect. During the swallowing of fluids, there is a tendency to regurgitation through the nose, though this is occasionally prevented by the approximation of the edges of the fissure in the soft palate.

Age for operation.—In the treatment of these malformations, the first question to be determined is the age at which the operation should be performed. As the success of the operation depends in a great measure upon the patient remaining perfectly tranquil and steady during the necessary procedures which are of a tedious and protracted character; upon his assisting the surgeon by opening his mouth, and not struggling on the introduction of the instruments; and, after the operation, upon his making as little movement as possible in speech or deglutition for some days; it is usually considered expedient not to interfere with this malformation until the patient has attained the age to understand the necessity of remaining quiet, and to be able to control his movements; yet some observations by Fergusson and Sédillot have shown that the necessary operation may be done successfully on young children. It need scarcely be remarked, that the general health ought to be in the best possible state, before any procedure requiring immediate union of parts be attempted.

Staphyloraphy.—The operation for the cure of a cleft in the soft palate may be said to have been introduced by Roux; for, although several attempts at the cure of this deformity had been made by surgeons before his time, yet he was the first to establish *staphyloraphy* as a distinct operation. Many modifications of Roux's plan have been practised by Gräfe, Warren, Dieffenbach, Liston, and others, in order to render it more easy of execution and certain in its results, and especially by making incisions through the palate so as to take off the traction on the sutures; but to Fergusson is due the great merit of introducing a new principle of treatment in the operation—viz., the application of myotomy to it, thus paralyzing the movements of the muscles of the palate. Fergusson found that the great cause of failure in these cases was the mobility of the parts, and the traction exercised by the muscles, principally the levator palati and the palato-pharyngeus, on the line of union; in order to obviate this, he conceived the happy idea of dividing these muscles. Before Fergusson laid down the principles of this operation, it is true that various cuts had been made in the palate by different surgeons, with the view of taking off the tension after the sutures were tied. Thus Dieffenbach, Pancoast, and Liston, all recommend that the traction on the stitches should be lessened by longitudinal or transverse incisions across the velum pendulum palati. Mettauer practised several small incisions for this purpose; and Mason Warren divided the anterior pillar of the fauces and its attachments to the posterior pillar, coming nearer than any previous operator to Fergusson's method. These operations, however, were done almost at hap-hazard, and in an empirical way, without the recognition of any distinct principle being involved in them.

In the operation as performed by Fergusson, there are four distinct stages. 1. The *muscles of the palate are divided*, by passing a curved lancet-ended knife through the fissure behind the velum, midway between its attachment to the bones and the posterior margin, and about half-way between the velum and the end of the Eustachian tube. By cutting deeply with the point of the knife in this situation, the levator palati is divided. The uvula is then seized and drawn forwards, so as to put the posterior pillar of the fauces on the stretch, which is to be snipped across, so as to divide the palato-pharyngeus. The anterior pillar, the palato-glossus, may then be notched in a similar way. 2. The next step in the operation consists in *paring the edges of the fissure from above downwards*, by means of a sharp-pointed bistoury. This is best done by seizing the lower end of the uvula, putting it on the stretch, and cutting first on one side and then on the other, leaving the angle of union to be afterwards removed. The patient should then be allowed to remain quiet, and to gargle the mouth with cold water or to suck ice, so as to stop the bleeding. 3. When the bleeding is arrested, the surgeon proceeds to the next step, that of *introducing the sutures;* this may be done by means of a nævus-needle, armed with a moderate sized thread, being passed from below upwards on the left side of the fissure, about a quarter of an inch from the margin; the thread should now be seized with the forceps, and one end of it pulled forwards through the fissure. This may again be threaded in the needle, and passed through the opposite side of the fissure from behind forwards through the right side; as the point of the needle appears, the thread should again be seized, and the needle at the same time withdrawn; the suture is then tied by means of the surgeon's knot; and in this way, according to the extent of the fissure, from two to four sutures may be passed and tied lightly, and the knots cut close. An important improvement in this method of passing the sutures is now very generally adopted. It consists in passing a single suture through the left side of the cleft from before backwards in the usual way. A needle, having an eye at its point, and threaded with a *loop* instead of a single thread, is now passed through the right side of the cleft, the loop drawn through, and the needle removed. The single suture is then slipped through the loop. This is then withdrawn, carrying with it through both sides of the cleft the single ligature. In this way the sutures, being passed on both sides from before backwards, can be inserted more evenly, and with less chance of puckering when knotted. In tying the knots, great care should be taken that no undue traction be exercised upon the parts; in fact, the use of the sutures is not to draw, but simply to *hold*, the parts together; the division of the muscles has caused these to be relaxed, so that they hang down loosely, and merely require to be held in apposition by the sutures. The patient must next be put to bed and every care taken to avoid any movement of the palate. He should be restricted to fluid but nourishing food for a few days,

and should be directed to swallow this with as little effort as possible, and indeed should not be allowed anything solid until complete union has taken place. All coughing, spitting, or swallowing of the saliva should be interdicted. 4. *The stitches should be left in for several days;* and, indeed, need not be disturbed so long as they produce no irritation. They usually require removal by the eighth or tenth day, but occasionally may be left with advantage for some time longer, until they excite irritation, or until union is perfect; they should then be cut across with scissors and drawn out, the upper one first, the middle next, and the lower one last. Should there be any aperture left in the palate, where union has not taken place, this may be closed by touching it with a point of nitrate of silver.

The voice in these cases does not usually at once recover its natural tone after the operation, although in some cases it may; but, at the end of a month or six weeks, the patient may advantageously be put through a course of instruction, with the view of regulating the movements of the tongue and the actions of the soft palate.

In dividing the levator palati, Pollock adopts a different practice from that of Fergusson. Instead of cutting from behind, he passes a ligature through the curtain of the soft palate so as to control it and draw it forwards; then pushing a narrow-bladed knife through the soft palate to the inner side of the hamular process he readily divides the muscular fibres by raising the handle and depressing the point. This method of dividing the levator palati, which is analogous to the plan

Fig. 438. Fig. 439. Fig. 440.

Sédillot's operation for staphyloraphy.

employed and depicted by Sédillot (Figs. 438, 439, 440), appears to be more simple and easy of execution than the division of the muscles of the velum from behind. The gap that is left closes without difficulty by granulation, and seems still more to take off tension from the parts.

Uranoplasty.—*Fissures of the hard palate* are usually closed by means of "obturators" made of gold, vulcanized India-rubber, or ivory. To Warren, of Boston, is undoubtedly due the merit of having been the first to close these fissures by a surgical operation. This he did by dissecting the soft tissues from the palatal arch between the margin of the cleft and the edge of the gum, and then uniting them in the middle line by means of stitches in the same way as in fissured soft palate. This operation was first brought before the profession in this country by Avery and subsequently by Pollock, who have invented some very ingenious instruments for its proper performance.

The operation is performed in the following way. An incision having been made along the edge of the cleft, at the junction of the nasal and palatal mucous membranes, the soft covering of the hard palate is carefully dissected or scraped down off the bones by means of curved knives, great care being taken that the mucous membrane and its subjacent fibro-cellular tissue, which varies greatly in thickness in different cases, be not perforated. Langenbeck has particularly recommended that the periosteum be detached with the fibro-mucous tissue; so that the flaps brought down may not only be thicker and stronger than they otherwise might be, but also that they may eventually throw out bone and thus close the gap by a firm opaque deposit. In doing this, Langenbeck uses a blunt instrument in preference

to a sharp angular one, and takes especial care to avoid the division of the attachments of the soft covering of the hard palate, at those points, anteriorly and posteriorly, where the bloodvessels and nerves enter. When these structures have been well loosened on each side, the covering of the palate will be found to hang down as a curtain from the vault of the mouth—the two parts coming into apposition along the mesial line, or possibly overlapping. The edges, being then smoothly pared, are brought into apposition by means of a few points of suture, thread or wire, the latter preferable, introduced in the ordinary way and without any dragging. On this point great care is necessary. The knots having been tied, the patient is confined to bed for several days, and allowed an abundant, but fluid or pulpy diet. Union will usually be found to be perfect at the end of a week.

There is a difference of practice amongst surgeons as to the closure of the gap in the soft palate at the same time as the one in the hard palate, or at a subsequent period. Pollock prefers a delay in the operation until the cleft in the hard palate is closed. Annandale has, however, operated successfully by closing the fissure in both palates at one sitting; and perhaps the wisest course to adopt is to close as much of both as the patient can bear at one time, and to leave the remainder of the operation to be completed at another opportunity.

Perforation of the Hard Palate.—Perforations of the hard palate, consequent on necrosis of the bones, the result of syphilis or injury, are not amenable to surgical treatment. In such cases, a well-fitting obturator will most effectually remedy the inconvenience.

CHAPTER LIX.

DISEASES OF THE MOUTH AND THROAT.

DISEASES OF THE TONGUE.

Tongue-tie.—Infants and even adults are said to be *tongue-tied*, when the frænum linguæ is shorter than usual, causing the end of the tongue to be depressed and fixed, so that it cannot be protruded beyond the incisors. If this malformation be considerable, suckling and distinct articulation may be interfered with; and then division of the fold becomes necessary, which may readily be done by snipping it across with a pair of round-ended scissors. In this operation, the risk of wounding the ranine arteries, that is sometimes spoken of, may be avoided by keeping the point of the scissors downwards towards the floor of the mouth.

Prolapsus of the Tongue has occasionally been met with, either as a congenital or an acquired condition; it has been described by Lassus and Crosse as consisting either in want of power in the retractor muscles, or in hypertrophy of the organ. In this condition, the tongue lolls out of the mouth, is greatly swollen, of a purplish color, but somewhat dry, with constant dribbling of saliva. If the swelling have existed for a long time, it may give rise to deformity of the teeth, and of the alveolus of the lower jaw, which is pushed forwards. In the *treatment* of this affection, little can be done unless it be excessive and permanent, when excision of a portion of the tongue by knife or ligature may be required. In children, the ligature would certainly be the safest, as excision might be followed by abundant hemorrhage, not very easy to arrest.

[Syme has shown that the operation of excision should be preceded by pressure and the use of astringent lotions. (*Obs. in Clin. Surgery*, pp. 180–191.)—A.]

Glossitis is a rare affection, more particularly when it occurs idiopathically; most commonly it results from profuse and injudicious salivation. In this disease the tongue is greatly infiltrated with serum and blood, becoming immensely swollen, so as to hang out of the mouth, with profuse salivation and inability on the part of the patient to swallow or speak, and perhaps a threatening of suffocation.

The *treatment* is as simple as it is efficient; it consists in making a long and free incision along the dorsum of the tongue on each side of the raphe, which gives free

and immediate relief by the escape of blood and infiltrated fluids. I have seen a patient, who was nearly suffocated by the immense size of his tongue, relieved at once by such incisions, and nearly well in the course of a few hours afterwards. Purgatives, especially of a saline character, are also useful; but these cannot be administered until after the swelling has been relieved in the way just mentioned.

Abscess of the Tongue, though rare, occasionally occurs. I have seen several instances of it. The abscess forms a small deeply-seated elastic but firm tumor, which sometimes feels slightly movable and presents no superficial discoloration. A boy was brought to me some time ago with an elastic tumor of slow growth, and of about the size of a small plum, situated deeply in the centre of the tongue; on puncturing it, about half an ounce of healthy pus was let out, after which the cyst speedily closed.

Nævus and Aneurism by Anastomosis are but rarely seen in the tongue, and when met with would require to be treated on the same principles that guide us in the management of the disease elsewhere. A very remarkable instance of an erectile tumor of a nævoid character affecting the tongue came under my care, in which the whole of the free extremity of the organ was implicated in the morbid growth, presenting a thin club-shaped end, which protruded between the teeth and the lips of the patient, a girl about three years old. In this case Image, of Bury St. Edmunds, had very judiciously arrested the activity of the disease, and had produced consolidation of the mass by the introduction of setons, which were worn for some months; and, when the child subsequently came under my care, the chief inconvenience that existed resulted from interference with speech, and the deformity occasioned by the hypertrophied and elongated organ (Fig. 230, p. 577.) By means of the écraseur I removed all the redundant tissues, and so reduced the tongue to its normal length and breadth.

Morbid Changes of the Epidermic Covering of the tongue sometimes occur; amongst the most remarkable of these is *psoriasis*. In this affection the tongue is indurated, shrivelled, and dry, having cracks upon its surface, with patches of a dead white color, and irregular in shape, varying in size from that of a split-pea to an inch in diameter; this condition, exactly resembling psoriasis of the palms of the hands, may occur with or without scaly disease of the general integument. I have seen it in both conditions, and have always found it a most difficult affection to treat. The preparations of arsenic, with Plummer's pill and sarsaparilla, have, however, appeared to afford the best results. In some instances it is evidently of syphilitic origin; and then it requires to be treated on the general principles that guide us in the management of the constitutional forms of that disease.

The surface of the tongue occasionally assumes a *glazed and warty character*, as if covered with a layer of boiled sago; the mucous membrane being œdematous, elevated, and papillated, but at the same time glassy and semi-transparent, and without induration. This condition, which usually arises from syphilis, requires the constitutional treatment of that disease.

A hard warty condition of the mucous membrane covering the end of the tongue is occasionally met with, giving rise sometimes to so much interference with speech, as to require removal either by the scissors or ligature.

Fissures or Cracks not uncommonly appear upon the side of the tongue, usually opposite the molar teeth, sometimes dependent on irritation of stumps, but not unfrequently on dyspepsia. These cracks may in some depraved states of the constitution extend rapidly, eroding away a considerable portion of the side of the organ in a short time, so as to leave a large and deep sloughy cavity with much dusky inflammation around it, with great fetor of the breath, and a copious discharge of saliva, which trickles out of the corners of the mouth; the patient being usually destroyed in from three to six months, by the irritation of the discharges, the inability to take food, and the supervention of hemorrhage.

Treatment.—This disease, which is a combination of sloughing and ulceration, is best treated in the early stages by the application of leeches beneath the jaw, and the use of chlorinated gargles, with a moderately antiphlogistic regimen; as it advances, the internal administration of arsenic is useful in some cases, with the application of the balsam of Peru, either pure or diluted with the yelk of egg, and the employment of gargles composed of the chlorides and the tincture of myrrh.

Syphilitic Tubercle is not unfrequently met with in the tongue, as one of the advanced symptoms of constitutional syphilis, forming an indurated irregularly

circumscribed mass, of a round shape, situated deeply in the substance of the organ, or towards the centre of the tip. The surface covering the tubercle is of a dusky red or coppery color; it rarely runs on to ulceration, though rhagades and fissures occasionally form around it; there is no fetid discharge, and no destruction of the organ.

The *treatment* consists in the administration of small doses of bichloride of mercury in sarsaparilla, under which the tubercle will rapidly disappear.

Encysted and other Tumors, requiring extirpation, are sometimes situated in the centre of the tongue, towards its mesial line. In such cases they may readily be removed by drawing the tongue forwards by means of a hook or piece of whipcord passed through its tip, and then dissecting out the morbid growth. Any bleeding that occurs may be arrested by passing a suture or two by means of a curved or cork-screw needle across the gap in the course of the divided vessels, and thus closing the aperture at the same time that the vessels are compressed.

[These operations are not always devoid of risk; Dr. William Hunt, of this city, met with a case of tumor (apparently glandular) on the posterior portion of the tongue, which he treated by ligation. Death followed on the third day, seemingly from a reflex involvement of the nerve centres. (*Trans. Coll. Phys.* in *Am. Journ. Med. Sciences*, January, 1866, p. 163.)—A.]

Cancerous and Cancroid Diseases.—These affections are usually epitheliomatous, and commence at the side or tip, with a tubercle or fissure; they more rarely appear as scirrhus in a solid mass in the body of the organ; encephaloid occurs very rarely, and only when the disease is recurrent. If a tubercle or warty growth appear, this is usually flat, indurated, and of a purplish-red color, gradually running into ulceration; if a fissure, this from the commencement has an indurated base, a foul surface, and an everted edge. As the ulceration extends, a chasm with ragged sides, a sloughy surface that cannot be cleansed, and a widely indurated base, gradually form; there are great fetor of the breath, and profuse salivation; and, as the disease progresses, implication of the mucous membrane and of the structures of the floor of the mouth, and of the submaxillary or sublingual glands, takes place. The lymphatic glands under the jaw usually become involved at an early period; but the disease may exist for a year or two without their becoming implicated. Cachexy at last supervenes, and the patient dies from the conjoined effects of exhaustion, irritation, and poisoning of the system. In some instances, when the posterior part of the tongue is very deeply affected, copious and fatal arterial hemorrhage may occur from the ulceration extending into the lingual artery.

Diagnosis.—The diagnosis of these various forms of disease of the tongue is important. The *foul and sloughing ulcer* may be distinguished from all others by the rapidity of its progress, its eroding action, and the absence of all induration at its base. *Syphilitic ulceration*, with an indurated base, commonly closely resembles cancer of the tongue; so closely, indeed, that it is only with great difficulty that the diagnosis can be effected. This, however, may generally be accomplished by observing that the syphilitic ulcer is elongated, irregular, and does not rapidly extend, and is associated with other less dubious evidences of constitutional syphilis; while the cancerous ulcer is of a more circular shape, has hard and eroded edges, and spreads with greater rapidity. The influence also of treatment will after a time throw light upon the nature of the disease; and the scrapings of the cancerous ulcer, when examined under the microscope, will always reveal its true character.

The diagnosis between the *syphilitic* and the *cancerous tubercle* is most important; here the duration of the disease and the coexistence of constitutional syphilis must be taken into account. It is also of much moment to attend to the situation of the tumor; the syphilitic tubercle being almost invariably met with deeply in the substance of the organ, whilst the cancerous growth is commonly seated at its edges or tip.

Treatment.—In the treatment of cancer of the tongue, therapeutic means are utterly useless. No measures hold out any chance of recovery, or even of prolongation of life, except the complete removal of the diseased structure; and this it is by no means easy to accomplish, as the cancerous infiltration often extends much farther than at first appears, passing deeply between the muscular fasciculi into the root of the tongue. In these deep cancerous affections there is usually great enlargement of the submaxillary glands, with infiltration of the floor of the mouth and

neighboring soft parts to such an extent as to render it impossible to excise or in any other way remove the whole of the disease.

The operations that are practised on the tongue when it is not too extensively affected by cancerous disease consist in the removal of a portion of the organ, or its complete extirpation from the hyoid bone, according to the situation of the disease and the extent to which the tongue is implicated.

Unless the disease can be very fully and freely extirpated, it is better not to attempt any operation; for in no organ is there a greater tendency to recurrence of cancerous disease than in the tongue. No operation should be undertaken when the disease extends to the floor of the mouth, implicates the arches of the palate, or has infiltrated the submaxillary glands.

Removal of a portion of the tongue.—Three methods of operation may be employed when a portion only of the tongue has to be removed—viz., the ligature, the écraseur, and the knife. When the extirpation of the whole organ is decided upon, the ligature is not applicable, and recourse must be had to the knife or the écraseur.

For the purposes of operation the tongue may be divided into three regions, viz., the anterior third, the central lateral portion, and the posterior part.

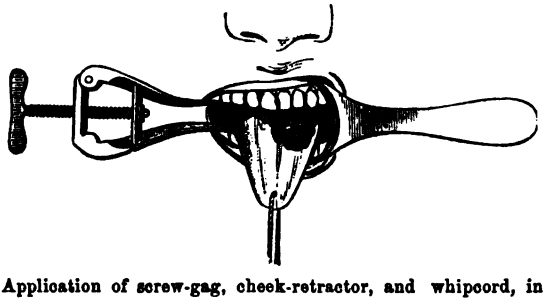
When the tip or anterior third of the organ is diseased, the ligature or the knife may be equally used. The écraseur, though applicable, is not needed.

When the more central and lateral part is involved in disease, and requires removal, the knife, the ligature, and the écraseur, are all available.

When the posterior part is involved, so that the whole organ requires removal, the surgeon should choose between the knife and the écraseur.

In all operations upon the tongue, care must be taken to prevent the patient from biting it, to expose it thoroughly, and to keep it under control. The first object is attained by placing a screw-gag between the teeth on the side opposite to the seat of operation; the other two by drawing the cheek aside by means of an angular spatula, and by passing a strong double whipcord ligature through the tongue about an inch and a half from its tip (Fig. 441), but somewhat towards the side to be excised. By this an assistant draws the organ out of the mouth. The light should be good for these operations, and the surgeon should have trustworthy assistants.

Fig. 441.



Application of screw-gag, cheek-retractor, and whipcord, in operations on the tongue.

Excision may readily and safely be done when the free anterior portion only of the tongue is diseased, or when it is only superficially affected at its back part; the hemorrhage that ensues, though abundant at the time, usually ceases of itself, or may be arrested by the ligature, by the actual cautery, and by the introduction of ice into the mouth.

Ligature is a plan which is very commonly employed. For the purpose of this operation strong thick saddler's whipcord is the best, as it does not readily cut through the soft and brittle tissue of the organ, which will be the case if the small compressed cord usually sold by the instrument-makers be used. There is little danger from hemorrhage in or after this operation; and the pain and subsequent discomfort are usually much less than might be expected. Hilton has removed the objection of pain by proposing and practising section of the gustatory nerve prior to the application of the ligatures. This part of the operation may, if thought necessary, be done by drawing the tongue forwards and dividing the mucous membrane and submucous tissue vertically for three-quarters of an inch, opposite the molar teeth, over the hyo-glossus muscle, and across the upper portion of the sublingual gland; much venous bleeding usually occurs, which embarrasses the search for the nerve, yet with a little dissection this may be exposed and divided, when sensation will cease in the whole of that portion of the tongue which is anterior to the line of incision. By means of the ligature any portion of the tongue, however deeply seated, may be securely strangled.

The ligature is passed by means of an ordinary nævus-needle, or, what is often

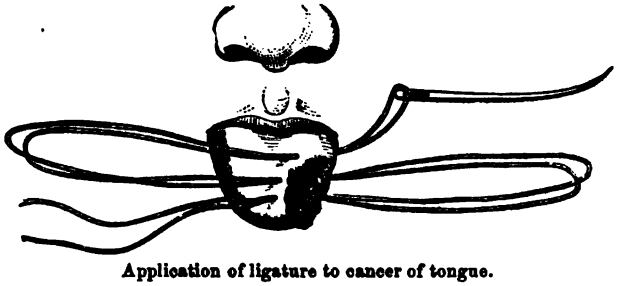
more convenient, a corkscrew needle curved on the side as well as to the point (Fig. 442). In many cases, the plan described for tying flat nævi will be found the

Fig. 442.

Corkscrew-needle.

most convenient mode of passing the whipcord round the cancer of the tongue (Fig. 443). In whatever way the ligatures are applied, care should be taken to pass them through the healthy tissue of the organ wide of the disease, and they should then be tied very tightly, so as to strangle the mass effectually. This may then be

Fig. 443.

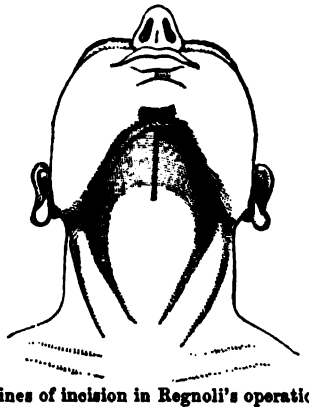


Application of ligature to cancer of tongue.

cut away by scissors, so as to diminish the quantity of slough that would otherwise be left in the mouth. Swelling of the tongue, followed by rather profuse salivation and fetor of the breath, attends this operation; but the mass, if properly constricted, will slough away in a few days, leaving a large gap that readily fills by granulation. When the disease exists so far back that it cannot readily be reached from the mouth, Cloquet, Arnott, and others, have successfully strangled it by making an incision in the hyoid region, between the genio-hyoid muscles forcing the ligatures by means of long needles through the base of the tongue, and then drawing them tight through the aperture in the neck, so as to constrict the diseased mass.

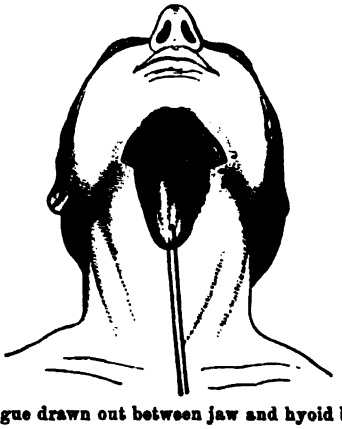
Regnoli has successfully extirpated large portions of the tongue for cancerous disease of the back of the organ, by making an incision of a semilunar shape, along the line of the lower jaw from near one angle of the bone to the other; then making

Fig. 444.



Lines of incision in Regnoli's operation.

Fig. 445.



Tongue drawn out between jaw and hyoid bone.

a vertical cut through the centre of this, from the hyoid bone forwards, dissecting back the flaps thus formed (Fig. 444), and then opening into the cavity of the mouth

through its floor, clearing the parts by a little dissection, and drawing the tongu through the opening down upon the anterior part of the neck, where the disease structures may be ligatured or excised (Fig. 445). The wound is then closed an united in the usual manner. By this means the surgeon can reach portions of th organ that cannot be easily got at in any other manner.

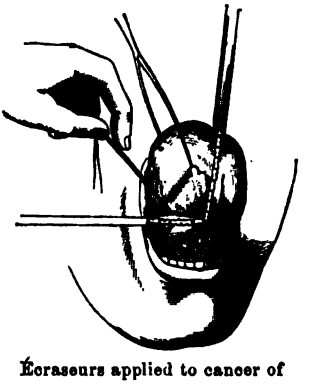
Removal of the whole of the tongue.—This bold and ingenious operation wa first performed by Syme in the following way: A vertical incision is made through the centre of the lower lip down to the hyoid bone, so as to expose the lower jaw, each side of which is then to be drilled through, so as to admit of the passage of a silver wire. The symphysis of the lower jaw is next to be sawn across, the mylo-hyoid muscles separated, the tendinous attachment of the genio-hyoid and genio-hyo-glossi muscles divided, and the larynx drawn forwards, when the whole of the tongue down to its hyoid attachments will be exposed, and may be removed by one stroke of the knife. After the lingual arteries have been tied, and all hemorrhage has been arrested, the opposite segments of the lower jaw must be brought together, and held in position by one silver wire suture, twisted round a tooth on each side, and by another passed through the hole previously bored in the bone on each side of the cut. The incision in the lower lip should also be united by wire sutures.

This operation has been attended by as great an amount of success as could have been expected from so serious a procedure. Of the first three cases operated on by Syme, one has recovered: and the operation has been successfully performed in two instances by Fiddes, of Jamaica, who has, by dividing and ligaturing the lingual artery, first on one side and then on the other, avoided all dangerous hemorrhage. After recovery, the patients were found to possess a fair amount of articulation. Buchanan has successfully modified the same procedure by the removal of the lateral half of the tongue from the hyoid bone.

The *écraseur* has been successfully used by Chassaignac in removing portions of the tongue. When the disease only occupies one side, and it is not thought necessary to cut away the whole breadth of the organ, two or more instruments are commonly required, which, as Chassaignac represents (Fig. 446), must be passed through the substance of the tongue in opposite directions, so as to isolate and detach the diseased portion.

If the whole thickness be implicated, and the disease extend far back, the tongue may be removed to any extent, even as far as its attachments to the hyoid bone, by means of a single écraseur.

Fig. 446.



Écraseurs applied to cancer of tongue.

In these extensive removals of the organ by this instrument, the tongue should be transfixed at its tip by a whipcord ligature, so that it may be well drawn forwards; the wire or chain of the écraseur should then be passed well back behind the diseased mass, and the whole of the part anterior to it extirpated in the usual way. This operation will suffice for disease reaching to the middle of the organ; but if it extend beyond this it may be taken away at its root by drawing it forwards, dividing the attachments of the genio-hyo-glossi muscles from the lower jaw, so as to pass the chain well under the tongue, and also far over its back, and then tightening the instrument.

Nunneley, of Leeds, has devised an ingenious mode of applying the écraseur so as to remove large portions of the tongue, or, indeed, the whole organ, as far back as the hyoid bone. This operation consists in passing the chain of the écraseur through the centre of the mylo-hyoid space by means of a sickle-shaped needle, about 4½ inches long and as broad as a bistoury blade. By this needle the chain is brought into the mouth close to the frænum. Two or three curved and strong hare-lip pins are now passed deeply into the tongue, obliquely, behind the seat of the disease, their points being made to project forwards below the organ, so as to prevent the chain from slipping. The loop is now gradually tightened, and the tongue is cut or shaved off obliquely from behind forwards.

When the tongue is extensively diseased and requires removal far back from or close to the os hyoides, the operation may be performed very conveniently by following the steps of Syme's procedure, so far as the division of the lower lip and

Fig. 447.

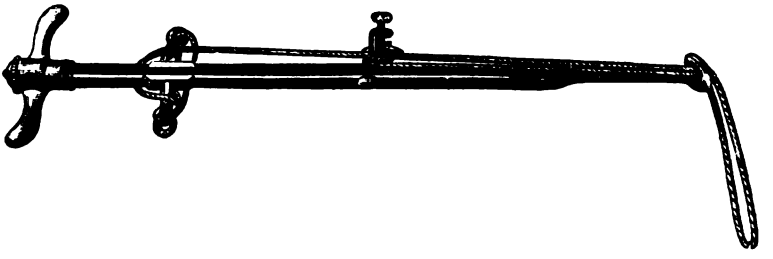
Removal of tongue by division of lower jaw and écraseur.

jaw is concerned. But, instead of cutting away the tongue with the knife, it may, as is represented in Fig. 447, and as has been successfully done at University College Hospital by Heath, be removed by means of the écraseur.

In removing large portions of the tongue by means of the écraseur (Fig. 448), the instrument should be worked very slowly, in order that time may be given for the vessels to contract; but, even with this precaution, hemorrhage may occur from the larger arteries to such an extent as to require the application of the ligature.

When the floor of the mouth is implicated in the morbid action, nothing should be attempted; as it is impossible to extirpate the whole of the disease in this situation, and partial removal of it will only be followed by rapid recurrence and increased activity of development. Slight enlargement of the submaxillary glands should not be any bar to the operation, provided the disease be limited, and the constitution good. If enlarged, the glands may be excised at the same time with the disease of the tongue; or, if they be not of very considerable size, they may be left, when they will perhaps subside without the necessity of operation, as their

Fig. 448.



Ecraseur for removal of tongue.

enlargement may probably be dependent upon simple irritation; should they continue indurated, they may readily be removed at a subsequent period.

In instituting a comparison between these three different methods of dealing with tumors of the tongue by ligature, the knife, and the écraseur, it should be understood that the same plan of treatment is not equally or indiscriminately applicable to all cases, but that one or other should be adopted according to the size, situation, and extent of the cancerous mass. If this be small and situated at the tip of the organ, this portion of the organ may be easily, quickly, and safely excised. If the disease be situated towards the side, so as to require the removal of perhaps one half of the anterior third of the organ, it may be cut out; but I think that it will be found safer and more convenient to remove it by ligatures. If it occupy the whole breadth of the anterior third, or even half of the tongue, I consider that removal by the écraseur is the simplest and safest procedure. If the posterior part be superficially affected, the disease may be cut out. But if the organ be so deeply affected that the whole of it requires extirpation, the écraseur will also be found to be easy of application and efficient in execution. After the division of the genio-hyo-glossi, however, should the surgeon not be able in this way to reach the farthest limit of the disease, he must have recourse to Syme's operation of the division of the lower lip and jaw in the central line, and the complete extirpation of the cancerous mass with the knife or écraseur.

Although distinctness of articulation is necessarily affected for a time by these operations on the tongue, yet it is usually completely restored when only the anterior third or half is removed; the tissue of the organ recovering its normal mobility with remarkable facility, and indeed appearing to possess a very considerable reparative power, so as almost to seem to be capable of reproduction to some extent.

Even after removal of the whole of the tongue, the power of deglutition is preserved, and that of articulation, although at first somewhat imperfect, eventually returns, so that the patient is able to speak so distinctly that strangers would not be aware of the loss he had sustained. Amongst the tortures to which Christian martyrs were subjected in the early ages, and the punishments which have been inflicted on heretics, "cutting out the tongue" was one of the most barbarous. Martyrologists in describing this horrible mutilation have remarked with wonder, that, although it was practised with the view of depriving the sufferers of the power of speech, yet it often failed in its effect, and those who had been subjected to it were enabled to speak afterwards as plainly as before. This they have attributed to direct miraculous intervention. But, as modern surgery has shown that the power of speech returns equally, whether a cancerous tongue have been extirpated by the knife of the surgeon, or a heretical tongue by that of the executioner, we must rather look upon the return of speech as a physiological act, than as a miracle specially wrought for the benefit of those mutilated in and for the propagation of the true faith.

Encysted, Fatty, and **Erectile Tumors** are met with in the tongue, and underneath it in the floor of the mouth. They require extirpation by the ligature, or enucleation with the handle of the scalpel or fingers, according to their situation and size; and for these irregular operations no special directions can be given. In removing such tumors as these, when situated under or by the side of the tongue, the knife must necessarily be used with much caution. It must, however, be borne in mind that, if these growths cannot be reached from the inside of the mouth, they may be got at by incision through the mylo-hyoid region, where there is but a slight thickness of soft parts between the surface and the floor of the mouth.

Fig. 449.

Ranula.

Ranula, the most remarkable of the buccal tumors, may occur under two forms.

1. A globular swelling, semi-transparent, evidently containing fluid, and often attaining the size of a walnut or pigeon's egg, may be situated under the tongue, pushing this organ upwards and backwards, and consequently interfering with deglutition and speech (Fig. 449). The walls of the cyst are usually thin, with small vessels ramifying on them; its contents are glairy and serous. This form of ranula is said to be a dilatation of Wharton's duct; but there is no proof of the disease being of this nature, nor is it very easy to understand how so small a duct can be dilated to so large a size as is occasionally attained by these tumors, which seem, in some cases, at least, rather to consist of distinct cystic formations, such as commonly occur in connection with other secreting glands.

The *treatment* of this form of ranula consists either in passing a seton through its walls, so that contraction may take place on this; or else in the excision of a large portion of the anterior wall of the cyst, the remainder contracting until it at last becomes obliterated.

2. Besides the ordinary form of ranula, an encysted tumor, partaking of this character, is occasionally met with, lying above the mylo-hyoid muscle, between it and the buccal mucous membrane. It projects more distinctly into the neck than into the mouth, and thus forms a large tumor under the angle and body of the jaw, soft or elastic, and semi-fluctuating, occupying, perhaps, all the space between the lower jaw and the hyoid bone on one side. It attains the size of an orange. In a case of this kind under my care, the contents of the tumor, which closely resembled cream-cheese in character, were found to be composed of well-formed epithelial scales and much fatty matter.

Treatment.—Such tumors are best treated by making a free opening into them from the mouth, squeezing or spooning out their contents, stuffing the cavity with lint, and allowing it to granulate and contract. If an attempt be made to extirpate them from without, the profuse hemorrhage, the firmness with which the cyst-wall is incorporated with surrounding parts, and the danger attendant on the free use of the knife in the neighborhood of such important parts as lie between the mylo-

hyoid muscle and the tongue, will render such an operation not only unsatisfactory, but hazardous.

DISEASES OF THE UVULA AND TONSILS.

Elongation of the Uvula.—The uvula occasionally, becoming elongated and hanging down into the pharynx, so as to touch the epiglottis and sensitive mucous membrane in its neighborhood, gives rise to great irritation of the fauces, and to a tickling or spasmodic cough, which can only be cured by removing the pendulous body. This little operation may be readily done by seizing the end of the uvula with a pair of polypus-forceps, and snipping it across near the root with a long pair of scissors. It is better not to remove the whole of the uvula. If this be done, throat-irritation is apt to continue. I have been most satisfied with the result of those cases, in which a stump from a quarter to the third of an inch in length has been left. For some years I have been in the habit of using a pair of "vulsellum-scissors" (Fig. 450), by which the uvula is cut off at the same moment that it is seized, thus rendering the operation easier and less irritating to the patient. A very ingenious American instrument, consisting of a pair of forceps and scissors combined, may be employed with the same view; viz., by closing the handles of this instrument the uvula is first seized, and is then immediately cut across (Fig. 451).

Fig. 450.

Vulsellum-scissors.

Fig. 451.

Forceps-scissors.

Tonsillitis.—The tonsils are not unfrequently the seat of disease, becoming inflamed or permanently enlarged. When inflamed, they become swollen and red, with much pain in the side of the neck and ear, increased by any attempt at swallowing; there is usually rather a profuse secretion of saliva, and a good deal of swelling under the angle of the jaws; the tongue is much coated with thick pasty mucus, and the voice is thick and nasal. The *treatment* consists in the application of leeches under the jaw, of fomentations, the inhalation of the steam of hot water, and low diet, which need scarcely be enforced, on account of the difficulty and pain in swallowing. If the mouth can be opened, much relief may be given by scarifying the tonsils with a probe-pointed bistoury; and, if abscess form, it should be opened early with a gum-lancet.

Hypertrophy of the Tonsils.—The tonsils may undergo various structural changes. They may become hardened and enlarged as a consequence of repeated attacks of inflammation, or chronically and indolently hypertrophied by an expansion or outgrowth of their follicular structure independently of any inflammatory attack; or this chronic hypertrophied state my be greatly increased by plastic inflammatory deposit.

When the tonsils are chronically enlarged, one usually suffers to a somewhat greater extent than the other. The condition is at once obvious, on opening the mouth and depressing the tongue so as to expose the fauces fairly, and cannot be mistaken for any other morbid state.

There are two distinct forms of chronic enlargement of the tonsils. In the one case, these organs become hypertrophied in otherwise healthy children in consequence of repeated attacks of inflammation more especially consequent on croup, diphtheria, scarlatina, or measles. In these cases the tonsils are red, congested, and very liable, under the influence of slight occasioning causes, to violent attacks of acute inflammation with ulceration or abscess.

The *chronic indolent hypertrophy* presents different characters; in it the tonsil is large, rather pale, hard, smooth, and semi-elastic. This disease is one which occurs in children and young persons who have a general tendency to struma of the mucous membranes and their appendages. Most commonly it develops without any assignable or external cause, usually commencing at five or six years of age, and gradu-

ally increasing up to puberty, a period when the functional activity of the glands is greatest, and when they are most exposed to irritation from zymotic diseases, especially scarlatina and measles. When once the tonsils have enlarged, they become a source of great inconvenience and of even serious derangement of health. The child is liable to attacks of inflammation of the throat, the tonsils then becoming congested, greatly swollen, and readily running into ulceration or suppuration. In consequence of these repeated attacks of inflammation, the enlargement of the tonsils increases, they become indurated, rugged-looking, and nodulated, projecting far forwards into the fauces, and sometimes even touching each other below the uvula. Respiration, articulation, and deglutition are now seriously interfered with. The mucous membranes of the nose and eyes become chronically congested, and there is an increased secretion, from the back of the throat and nose, of thick, tenacious, unhealthy, or fetid material, the swallowing of which is deleterious. The child cannot sleep without snoring, and is apt to start up with a feeling of suffocation; the voice becomes thick and husky; the sense of hearing is blunted; and, partly from the incipient deafness, partly from the difficulty of breathing, causing the child to keep its mouth half open, the countenance assumes a peculiar vacant, semi-idiotic expression, which is very characteristic of the advanced stages of the disease. The most serious effect is the impediment to inspiration, which in the more chronic and severe forms of enlarged tonsils will go to such an extent as to prevent the full inflation of the lungs, and thus occasion a permanent flattening and contraction of the chest, imperfect aëration of the blood, and an interference with general nutrition.

The *treatment* of chronic enlargement of the tonsils will vary according to the age of the child, and the degree and kind of hypertrophy and induration of these organs. In the earlier and slighter forms of the disease, the enlargement of the tonsils may gradually subside as the child grows older and stronger; and it is well not to be in too great a hurry to excise the tonsils in young children, but rather to adopt a course of constitutional treatment with the view to the improvement of the general health by means that are ordinarily had recourse to in the management of struma. The internal use of iron, and the local application of the tincture of iodine, of nitrate of silver, or of burnt alum, are occasionally serviceable. In the majority of instances, however, the disease will not be materially influenced by any therapeutic means that may be adopted: and as the enlargement, continuing or increasing, gives rise to difficulty in respiration, and thus interferes with the due arterialization of the blood in the lungs, and impairs the child's speech, it becomes necessary to remove that portion of the growth which projects beyond the arches of the palate. This may best be done by the ordinary tonsil-guillotine. The ring of the instrument being passed over the tumor, the cutting blade is pushed forwards, and thus a slice of the projecting part of the growth is removed. In some cases difficulty is experienced in bringing the tonsil fairly into the ring of the instrument; this may be obviated by drawing it through with a vulsellum or double hook, and indeed, in some of the machines sold for the purpose a double hook is attached, which, being fixed into the tonsil, draws it forwards before it is sliced off (Figs. 452, 453). In performing this operation it is best for the surgeon to stand behind the patient, more particularly in excising the right tonsil, as he can thus look better into the mouth and have more command over the head. Should a

Fig. 452.

Tonsil-guillotine shut.

Fig. 453.

Tonsil-guillotine applied.

drawing it forwards, and then taking off a slice with a probe-pointed bistoury, the base of the blade of which should be wrapped round with a piece of plaster, to prevent its wounding the tongue. In excising the tonsil in this way, care must be taken to cut downwards and inwards towards the mesial line, and on no account to turn the edge of the knife outwards, lest the internal carotid artery be endangered. The hemorrhage that follows this operation is usually very trifling; but it may be sufficiently abundant to endanger the patient's life. In such cases, ice and gallic acid will usually arrest the bleeding. In one case I found a gargle of spirits of turpentine suspended in mucilage effectual after all other means had failed.

It has been supposed by some that excision of the tonsil is liable to be followed by want of development of the testes. This I have never observed. But it is possible that enlargement of the tonsils to such an extent as to impede respiration, and consequently interfere with nutrition, may lessen the due development of the generative or any other organs of the body.

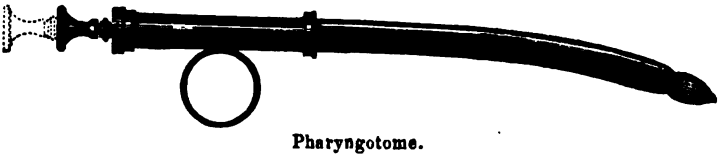
Malignant Disease of the Tonsil is not of common occurrence. I have, however, seen instances both of scirrhus and of epithelioma in this organ as a primary affection. In these cases the disease speedily extends to the pillars of the fauces, the pharynx, and onwards to the floor of the mouth, the glands under the angle become implicated, extensive infiltration of a brawny character takes place in and around them, the swallowing becomes extremely painful and difficult, respiration is impeded, the pharynx and palate become congested and loaded with viscid mucus, and the patient eventually dies in a distressing manner, partly from starvation, partly from constitutional contamination. Surgery only offers the means of relief in these sad cases, but can do nothing of a curative character. In a case of encephaloid of the tonsil which was under my care, I obtained some temporary advantage by removing portions of the soft projecting and very vascular tumor by means of the écraseur.

DISEASES OF THE PHARYNX.

Inflammation of the Pharynx of a diffuse erysipelatous character, with low fever, not unfrequently occurs; it is best treated by the application of a strong solution of nitrate of silver, the use of emollient gargles, and the internal administration of ammonia, with bark, stimulants, and support. If it have a tendency to run into sloughing action, the internal administration of the mineral acids, with bark and stimulants, the nitrate of silver lotion, and chlorinated gargles, are useful. Sometimes abscess forms in the substance of the velum, and then requires to be opened with a narrow-bladed bistoury.

Abscess occasionally forms in the areolar tissue behind the pharynx, between the vertebral column and its posterior wall, which is consequently pushed forwards so as to occlude the posterior nares, giving rise to a peculiar nasal intonation of voice if the abscess be situated high; if lower down, the consequences are more serious, as it may interfere with respiration by pressing upon the upper part of the larynx. This kind of abscess is often connected with disease of the bones at the base of the skull, or of the upper cervical vertebræ. In many cases, if left to itself, it would burst through the mucous membrane into the mouth; but in others it comes forwards under the sterno-mastoid muscles into the forepart of the neck. By exploring the pharynx with the finger, which may readily be done, tension and fluctuation through its posterior wall may easily be made out.

Fig. 454.



Pharyngotome.

In these cases the *treatment* simply consists in letting out the matter by puncturing the tense membrane covering it. This may be done by means of a sharp-pointed

bistoury properly protected, the ordinary abscess-knife or a pharyngotome (Fig. 454). The pus let out is usually offensive, even though the bones be not affected.

Tumors are occasionally met with in the postpharyngeal areolar tissue, giving rise to the same swelling, difficulty in respiration and deglutition, and lateral projection, as occur in abscess of this region. These growths are mostly *cancerous*, and speedily prove fatal. *Polypi* in the pharynx usually come down from the nasal cavities, but sometimes spring from the inside of this canal on one or other of its margins. They are usually, when truly pharyngeal, of a malignant character, and grow with great rapidity. The uses of the part are necessarily interfered with, and death may eventually result from obstruction to deglutition and respiration. *Epithelioma* of the pharynx has occasionally been met with. This form of the disease, which is of rare occurrence, does not differ from similar growths elsewhere.

STRICTURE OF THE ŒSOPHAGUS.

All diseases of the œsophagus have a tendency to constrict and eventually to occlude its passage, and hence are commonly described as *strictures* of it. In some instances, the constriction of the œsophagus may be of a purely *nervous* or *spasmodic* character; but in the majority of instances it is the result either of fibrous or cancerous degeneration of the walls of the canal, and is then termed the *organic* stricture. The simple non-malignant or fibrous stricture in most instances eventually degenerates into epithelioma, and hence appears to be more rare than it in reality is, as it is seldom met with after death in its undegenerated form. Scirrhous and encephaloid growths may, though rarely, develop in and around the œsophagus.

The great feature of œsophageal stricture is difficulty of deglutition; but dysphagia may arise from many causes besides œsophageal stricture. Hence its diagnosis is in the highest degree important.

Conditions Producing Dysphagia Independently of Stricture.—There are at least eight different conditions met with in the neck and chest capable of giving rise to dysphagia by compressing the œsophagus, independently of any stricture of that canal.

1. *Tumors connected with the pharynx.*—Putting out of consideration tumors of the tonsils, which would always be readily discovered, *polypus* of the pharynx may hang down and offer obstruction to the passage of food. In all polypoid growths connected with the pharynx (which are exceedingly rare) the nature, connections, &c., of the growth may be made out by drawing the tongue well forward, keeping it fixed with the tongue-spatula, and passing the finger well down behind the root of the organ; the pharynx can thus be explored, even below the root of the epiglottis, without much difficulty. *Abscess* may exist between the posterior wall of the pharynx and the spine, possibly arising from caries of the cervical vertebræ; or a *postpharyngeal tumor*, as, for instance, a carcinomatous growth, may be developed from the bodies of the vertebræ, and push the pharynx forwards. The eye is often deceived in these cases, failing to detect the existence of an enlargement at the back of the pharynx; but the finger readily recognizes it. In the case of abscess there is fluctuation, and the dysphagia will be removed by opening the abscess and letting out the contents; and the solid, or semi-solid and soft, or other feel of a tumor in this situation will lead to a very probable guess as to its nature.

2. *Morbid conditions of the larynx.*—Œdema about the back of the epiglottis, or chronic œdema, ulceration, and thickening of the mucous membrane there, or œdema about the rima glottidis, may give rise to a tendency for liquids to pass into the air-passages, and thus occasion a serious impediment in swallowing, the difficulty being attended with a feeling of spasm and suffocation. By passing the finger down behind the root of the tongue, the state of parts can often be felt; but the combination of dysphagia with a suffocative fit, and these probably associated with laryngeal cough, are the chief points to be attended to in the diagnosis.

3. *Tumors in the neck outside the œsophagus.*—Enlarged glands or a carotid aneurism, developing posteriorly, as has been known to occur with the internal carotid artery; or a tumor connected with the thyroid body, tightly bound down by the sterno-mastoid and fascia, may, by pressing on the œsophagus, give rise to dysphagia. In all cases where that symptom is complained of, the neck should be examined carefully for tumors, which will generally be very readily detected, espe-

cially where the difficulty has existed for some time, and the person has become much emaciated from deficient nourishment.

4. *Aneurism of the innominate artery.*—When the disease has risen into the root of the neck it is easily recognizable; but in certain cases it develops first in a direction backwards, and then one of the earliest symptoms is dysphagia. Indeed, the patient may suffer but little from any other symptom, and may apply to the surgeon for relief from it alone, quite unconscious of the existence of any serious disease. The diagnosis will be effected by careful attention to the symptoms described at pp. 623–624. In such a case, much danger might be incurred by at once putting an instrument into the œsophagus, under the impression that stricture existed; for the point of the bougie, or whatever instrument might be used, might perforate the sac of the aneurism, and so give rise to instant death.

5. *Aneurism of the aorta*, whether of the fusiform or sacculated variety, may give rise to difficulty of deglutition by pressure on the gullet. In this case, also, there is great danger of the aneurismal sac being pierced by an instrument passed down for the purpose of ascertaining the existence of stricture. The presence of the symptoms of intra-thoracic aneurism, described at pp. 619–623, will determine the diagnosis.

6. *Intra-thoracic tumors*, such as enlarged bronchial glands, cancerous and other tumors, may be developed from the thoracic spine into the posterior mediastinum, and so compress the œsophagus. In such cases the diagnosis is very difficult. It is difficult enough to determine the existence of a tumor, but still more so to distinguish it from an aneurism undergoing consolidation; but dulness on percussion, and dyspnœa with dysphagia, together with fixed pain in or to one side of the spine, with neuralgia down the arms or up the side of the head, and a varicose condition of the superficial veins of the chest, are the signs on which we place our chief reliance in diagnosing the existence of a tumor. Indeed, in the diagnosis of aneurism of the aorta and of mediastinal tumor, I look upon the combination of dyspnœa with dysphagia, and fixed wearing pain between the shoulders, as of the greatest importance.

7. *Dislocation of the sternal end of the clavicle backwards*, whether merely a simple dislocation, or produced in consequence of excessive curvature of the spine, may give rise to difficulty of deglutition. Of the latter kind there is at least one case on record, which is narrated by Sir Astley Cooper, in which the sternal end of the clavicle by its pressure so obstructed the passage of food, that the patient was brought into a condition of extreme danger. The surgeon, under whose care the patient was, very skilfully and creditably sawed through and detached the sternal end of the clavicle, and thus relieved his patient from the imminent danger in which she was placed.

8. *Impaction of a foreign body in the gullet.*—If a man swallow such a thing as a piece of mutton-bone, or the settings of artificial teeth, it generally lies across the gullet in such a manner as to be easily felt by the surgeon on passing a probang; but there are other cases in which a foreign body becomes so lodged in the canal as to escape detection and removal. Some years ago I was requested to see a patient who was said to have swallowed a piece of gutta-percha. He had, it appeared, in consequence of having lost several teeth, endeavored to construct an artificial masticatory apparatus for himself, which had become loose, and he had accidentally swallowed it. A few days afterwards, finding that deglutition continued difficult, he consulted a very able surgeon, who carefully examined him; but, not detecting any foreign body, he considered that the piece of gutta-percha had passed into the stomach, and that the œsophagus had been scraped by it in its passage down. Inability to swallow solids came on. I saw him six months afterwards. The question then was, whether the foreign body was still impacted in the œsophagus, or whether the symptoms arose from damage inflicted on that tube. I examined the œsophagus most carefully, but failed, as other surgeons had previously done, to discover the existence of any foreign body. I thought that the œsophagus had been injured in some way, and that probably epithelioma was developing itself, and would, sooner or later, prove fatal. One day, while at dinner, the patient suddenly vomited a large quantity of blood, and fell down dead. On examination after death, we found that the piece of gutta-percha had formed for itself a bed in the wall of the œsophagus, lying parallel with the inside of the tube, and that the ulceration of the mucous membrane caused by its presence had opened some œsophageal vessel—which, we

could not ascertain (it was not, however, either the carotid artery or the jugular vein); thus giving rise to the copious and sudden hemorrhage which had caused the patient's death. The surface of the gutta-percha which looked into the œsophagus, being constantly covered and smoothed over by mucus, and being protected, as it were, by a rim of swollen mucous membrane all around it, had allowed the probang to pass easily without its presence being detected.

These, so far as my experience goes, are the eight conditions which are likely to simulate stricture of the œsophagus; and such are the points to be attended to in the diagnosis of these affections from each other. With regard to their diagnosis from stricture, the process is rather a negative than an affirmative one, proving the absence of tumor, aneurism, &c. The conclusion that the difficulty of deglutition can arise from no other cause than stricture is arrived at by a process of exclusion; and the situation and extent of the stricture are ascertained by exploration with a gum-elastic catheter or bougie.

Forms of Stricture.—There are three forms of this affection which it is necessary to distinguish from each other, inasmuch as they differ greatly in the mode of treatment, and in the ultimate result. These are: 1. Hysterical or spasmodic stricture; 2. Fibrous stricture; 3. Carcinomatous stricture.

1. *Hysterical or spasmodic stricture* is met with chiefly in young females under twenty-five, though it may occur in much older persons of the hysterical temperament. It is possible for it to occur without evident organic disease or change of any kind. But I believe that the simple and pure uncomplicated hysterical stricture is of very rare occurrence. In the majority of instances it will undoubtedly be found to be associated with and dependent upon some local change of structure, most commonly of a simple kind, such as chronic inflammation of the pharyngeal mucous membrane, ulcerative abrasion of it, or follicular inflammation about the epiglottis and posterior part of the larynx. The disease in many cases is supposed to be dependent on or originally occasioned by the patient swallowing some foreign body, as a fish-bone, bead, bristle, &c., which after many months is still thought to be impacted. This is almost always erroneous. The foreign body may have been swallowed, and may have been the starting-point of the slight inflammatory or ulcerative action that occasions the dysphagia, but it has long since disappeared, merely leaving a series of troublesome consequences in its train. The obstruction is generally high up in the pharynx, rather than in the œsophagus; being produced by the contraction of the constrictor muscles of the pharynx. The dysphagia is intermittent; when the patient's mind is allowed to dwell long on the affection, and she becomes anxious about it, then the difficulty is greatly increased; whilst at other times, when her thoughts are diverted from it, food passes easily. It will be found also, in these cases, that on attempting to pass a probang or large bougie, its progress will at first be resisted, but, by patiently and gently pressing down upon the stricture, the instrument will soon pass easily.

2. *Fibrous stricture.*—There are two kinds of organic stricture of the œsophagus, namely, the fibrous and the cancerous. Between these the diagnosis is often very difficult; strictures originally fibrous sometimes degenerating into or assuming a malignant form; while others continue fibrous from the first. The fibrous stricture is scarcely ever idiopathic. It almost invariably originates from the cauterization of the interior of the œsophagus by the accidental or suicidal swallowing of some corrosive fluid, acid or alkaline, as the strong mineral acids or soap lyes, by which the mucous membrane is destroyed, charred as it were, and a cicatrix as of a burn forms. The etiology, in fact, is an important element in the diagnosis, the fibrous being almost invariably the direct result of escharotic action, the cancerous occurring without assignable cause, or being referred to some slight form of local irritation. Generally, on passing an instrument, we find that in the simple fibrous stricture it passes smoothly, and gives no sensation of roughness, no feeling of lacerating its way, or as if it were passing over an ulcerated surface; no blood follows its withdrawal, and the patient does not bring up pus, or pus and blood, though there may be copious mucous discharge. There is no material enlargement of the neck, no swelling of the cervical glands, no sign of the cancerous cachexia.

3. *Carcinomatous stricture.*—In the malignant or carcinomatous stricture the instrument seems to pass over a rough and ulcerated surface, its introduction is followed by blood, and the patient coughs up blood, or blood and pus, mixed

Fig. 455.

Carcinomatous stricture of œsophagus.

often with shreds of tissue—conditions all indicating a loss of substance (Fig. 455). There is also, generally, an ovoid or elongated swelling at the root of the neck; the neighboring glands may be affected; there may be cancerous tumors elsewhere; and the symptoms of the cancerous cachexia may be present. A fibrous stricture may, however, and very commonly does, degenerate into a malignant one—into epithelioma, though, perhaps, not into scirrhus or encephaloid. The special causes of cancer of the œsophagus are not known.

Treatment.—The treatment of stricture of the œsophagus will depend upon its nature. In the *hysterical variety*, the occasional introduction of a full-sized œsophagus-bougie, the application of belladonna to the neck, and anti-hysterical treatment generally, iron, aloetics, douches, and diverting the patient's mind from her malady, are the means to be employed. In such cases, Garrod has very advantageously employed large doses of assafœtida.

The treatment of *organic stricture* is more difficult. In it care should be taken that the patient is principally kept upon nutritious slops, or upon meat that has been well chopped up, as larger fragments are apt to become impacted at the seat of constriction. The difficulty in deglutition will, however, gradually increase, the patient being unable to swallow solids, then being reduced to pulpy food, and at last to liquid. After a time, he will not even be able to swallow these; and then it becomes necessary for the surgeon to feed him by the introduction of a gum elastic catheter through the stricture, and the injection of a sufficient quantity of liquid or semi-pultaceous nourishment into the stomach twice a day. After a few weeks, the irritation induced by the repeated introduction of the catheter will render its passage more and more difficult, until at last it becomes impossible to get it through the constriction. The patient may still be kept alive for some weeks by nutritive enemata, but at last dies of exhaustion and starvation. Even in cancerous stricture of the œsophagus, death seldom occurs by secondary deposits, or by constitutional contamination, but in the way just pointed out. In some cases the disease extends to the posterior part of the larynx, the mucous membrane covering the arytenoid cartilages and the epiglottis becomes involved, laryngeal stridor and dyspnœa ensue, and death may result from laryngeal spasm, unless life be prolonged by tracheotomy, which in most cases becomes necessary.

Such is the miserable course and termination of an organic stricture of the œsophagus. But the question now presents itself, can nothing be done to cure or even to arrest this disease?

The *palliative treatment* that is usually adopted in these cases consists in the introduction of bougies, and an attempt to thus dilate the stricture exactly as in the case of a constriction of the urethra. In introducing bougies into the strictured part of the œsophagus, there is, however, often a good deal of difficulty in making the point of the instrument enter the narrowed portion of the canal. This is more particularly the case when the constriction commences suddenly; the œsophagus, as is frequently the case, being dilated into a pouch-like sac above it, in which the food is apt to lodge, and the end of the instrument to be arrested, and at the bottom of which a narrow orifice exists, leading into the lower portion of the canal. In these cases, much patience and care may be required in overcoming the difficulty. Besides the ordinary dilatation by gradually increasing the size of the instruments used, I have in some cases seen temporary benefit result from the use of a catheter, surrounded by a tube of vulcanized India-rubber, which admitted of dilatation by the injection of water or air when introduced through the stricture; or from the employment of a tubular instrument, by passing a long small-sized bougie through the constriction, and then slipping a gum-elastic catheter with a rounded terminal aperture over it. It is needless to observe that, in the treatment of stricture of the œsophagus with bougies, no force should be used, lest the walls of the canal be perforated.

From these means temporary relief may result in some cases; but can an œsophageal stricture be thus cured? I believe not. If the stricture were ordinarily fibrous, as in the urethra, a cure might possibly be expected. But this form of œsophageal constriction must be excessively rare; and if the disease can be made

out to be cancerous, but little good, and most probably much harm, will result from the irritation of dilating instruments. We may, therefore, employ dilatation as a means of temporary benefit, but not with the hope of effecting a cure. Should the stricture at last become so tight as no longer to allow the catheter to be passed, and food to be thus injected into the stomach, the patient must inevitably die of inanition, unless kept alive by nutritive enemata. By these means I have known life prolonged, by a frail tenure it is true, for many weeks. In such cases it is an interesting physiological fact that, although the patients may continue to be moderately well nourished, and do not feel the pangs of hunger, they suffer excessively from thirst.

Has surgery no resource in those cases in which the stricture has become impermeable, and in which neither food can be swallowed nor a catheter passed, and in which, consequently, the most miserable death, that by starvation, is impending? In such cases it has been proposed by Sédillot, to open the stomach by an incision through the abdominal walls, and thus directly introduce food into the organ. This operation has been practised several times by Sédillot, Fenger of Copenhagen, Forster, and others. Sédillot, who has given it the name of *gastrotomy*, lays down the following rules for its performance.

Operation of Gastrotomy.—The patient lying on his back, the surgeon, who stands on the right side, makes a crucial incision, each limb of which is about an inch and a half in length, on the left side of the mesial line of the abdomen, two fingers' breadth to the inner side of the costal cartilages, and about one-third nearer to the ensiform cartilage than to the umbilicus; having previously satisfied himself by percussion and palpation that the liver is not in his way. The dissection is carried through the abdominal wall, and the peritoneum is opened. The surgeon then feels with the left index finger for the left border of the liver; by following this upwards, the stomach is reached. This organ is then seized with forceps, drawn forwards and examined, so that its identity may be established. By means of three or four points of suture, the anterior wall of the organ is then fixed to the edges of the aperture in the integuments, and an opening is made into it about midway between its two extremities, and a little above the lower margin. Nutritive injections must not be made into the artificial opening for the first few days; not, in fact, until consolidation of the wall of the stomach to the parietal peritoneum has been secured, and a fistulous opening thus fairly established. This must be kept patent by properly adapted silver tubes, through which the nutritive injections are to be made.

[A single incision, in the line of the left *linea semilunaris*, is recommended by Forster and Durham, as preferable to the crucial incision of Sédillot. (*Guy's Hosp. Reports*, 3d s., vol. xiv. p. 203.)—A.]

The value of this operation has as yet to be determined by experience. In no case in which it has hitherto been done has it succeeded in adding much, if anything, to the prolongation of life. In reasoning upon it, two objections present themselves. First, there is the great and immediate danger of destroying life outright by the induction of peritonitis; though it is by no means impossible that the tendency to abdominal inflammation may be lessened by the previous starvation of the patient. But supposing this risk to be overcome, what is gained by the artificial opening? It is true that through it the patient might be nourished; but, as every idiopathic stricture of the œsophagus is either from the first of a cancerous character, or eventually assumes a malignant action, of what advantage is it to endeavor to prolong a precarious existence, which must in a few weeks or months be cut short by the unchecked progress of a malignant disease? Would not the immediate danger of the operation much more than counteract all good to be eventually derived from it?

There is, however, one class of œsophageal strictures which are of the most obstinate character, and rapidly fatal by simple occlusion of the tube, without any tendency to malignancy. These are the constrictions that result from the swallowing of corrosive liquids, whether acid or alkaline. In such cases as these, in which speedy death by starvation is inevitable, I think that recourse might with propriety be had to the operation of gastrotomy.

[These cases, however, are never quite hopeless: a lady under the care of Mr. Hutchinson was reduced to such a low state by a stricture of the œsophagus produced by caustic potash, that gastrotomy was resolved upon, and an hour fixed for the operation; at the last moment her condition was found to have undergone spon-

taneous improvement, and from that time convalescence began. As Mr. Hutchinson justly observes, the advocates of gastrotomy can produce no case with so favorable a termination. (*Lond. Hosp. Reports*, vol. iv. p. 56).—A.]

DISEASES OF THE LARYNX.

The larynx may be the seat of a great variety of morbid conditions. Acute, œdematous, and follicular inflammation; ulcerations and chronic thickenings of the mucous membrane; inflammation and necrosis of its cartilages; and the formation of tumors or polypoid growths in its interior, may all occur.

Laryngoscope.—It is of the utmost importance in the diagnosis, and for the proper treatment of many of these affections, that a view should be obtained of the parts that are the seat of disease. This can only be done by means of the *laryngoscope*.

The introduction of this instrument into practice and its perfection have been a work of time.

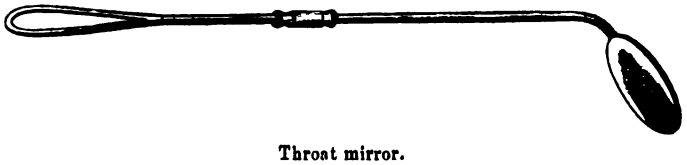
It appears to have been invented and first used in 1829, by Babington, who, under the term "Glottiscope," described an instrument consisting of a small mirror fixed to a wire shank, which, being placed against the palate whilst the tongue was held down, enabled him to view the glottis and upper part of the larynx; more especially when he illuminated these parts by throwing reflected light upon them from a mirror held in his left hand. Liston, Trousseau, and Avery, all made attempts in the same direction. But it was the celebrated singer Garcia, who, by throwing the sun's rays into the back of his mouth from a mirror held in his left hand, and then introducing a dentist's reflector into his mouth, saw the image of his own larynx and studied

Fig. 456.

Application of the laryngoscope.

its movements in the reflection in the looking-glass. Hitherto, however, laryngoscopy had not been employed in the study and diagnosis of diseases of the larynx, and it is undoubtedly to Czermak that the merit is due of having been the first to make this application of the art.

Fig. 457.



Throat mirror.

The *laryngoscope* essentially consists of two instruments, a reflector (Fig. 456), which is attached by an elastic band to the surgeon's forehead, and a mirror (Fig. 457), which is held in his left hand.

The mode of application and of use is extremely simple, and is illustrated in Fig. 456. The patient sits with his back to a good light—that of the sun is best, or of a moderator lamp. The surgeon, facing the light, reflects it strongly into the back of the open mouth of the patient. The tongue may, if necessary, be depressed with a spatula, and the small mirror, properly warmed, is then passed to the back of the fauces, the uvula or soft palate being slightly pressed backwards or upwards. The reflection of the glottis and of the contiguous parts of the larynx will then be seen in it.

Laryngitis.—Inflammation of the larynx principally occurs in adults, from exposure to cold, to the infection of erysipelas, or to the general occasioning causes of the low forms of inflammation. It differs essentially from the croup of children, which is attended by an albuminous exudation, and spreads downwards into the bronchi; whilst in laryngitis there is no effusion of plastic matter, and the disease is confined to the larynx itself. Laryngitis may not only be of an acute or a chronic kind, but the acute form likewise presents two distinct varieties according to the parts affected, the cause from which it arises, and the condition of constitution in which it occurs: in one, the true *acute laryngitis*, the inflammation is chiefly seated in the mucous membrane and cartilages; in the other, the *œdematous laryngitis*, the affection chiefly occurs in the submucous areolar tissue, within and around the larynx.

In all inflammatory affections of the larynx, whether acute or chronic, there is great danger to life; the rima glottidis, that narrow chink through which all the air destined for respiration must enter, becomes readily occluded, and asphyxia consequently results. This may happen either by the swelling of the lips of the glottis, from the effusion of plastic matter within or upon them, or by the occurrence of spasm in the larynx; indeed, there is always more or less spasm conjoined with all the inflammatory affections of this part of the air-tube; and this spasm, being superadded to already existing mechanical occlusion, commonly proves fatal. These laryngeal spasms do not at first recur oftener than at intervals of half an hour or an hour; but as the disease advances they become more frequent, and in any one of them the patient may be carried off. It is of importance to bear in mind that death may occur in these cases, although a considerable portion of the cavity of the larynx continue free. Thus Cheyne states that there are always in croup at least three-eighths of the cavity of the larynx open for the transmission of air; and that death must consequently result from some other cause than mere mechanical obstruction. This freedom from permanent occlusion commonly occurs in cases of laryngitis; and the immediate cause of death in the majority of instances appears to be spasm, conjoined with defective arterialization of the blood, which, becoming dark and poisonous, causes congestion of the lungs or brain, and thus low pneumonia and convulsions.

Acute Laryngitis.—The *symptoms* are those of local inflammatory action of an acute kind, conjoined with those of interference with the proper admission of air to the lungs. The cartilages and the mucous membrane are the parts principally inflamed, and but little effusion takes place under the mucous membrane; hence the symptoms are not always indicative of such early or intense interference with respiration, as is met with in the œdematous form of the disease. In acute laryngitis there are pain and tenderness on pressing upon the larynx, more especially about the pomum Adami. The voice at first is harsh and rough, then stridulous or sonorous; and deglutition becomes difficult. The difficulty in swallowing is often at first the most prominent symptom, and continues throughout; dyspnœa, often of a spasmodic character, then appears, the lips becoming livid, the features pale and bedewed with perspiration, the eyes watery and bloodshot, and the respiratory muscles being called into violent action: the nostrils are dilated; gasping efforts at breathing, and sudden fits of increased difficulty in inspiring, come on; at the same time the pulse becomes feeble, though it continues rapid: and, unless efficiently relieved, the patient will speedily sink. When it proves fatal, the acute usually runs into the œdematous form of laryngitis.

Treatment.—The treatment should be actively antiphlogistic. No time must be lost, otherwise the patient will fall into a hopeless state of asphyxia. Free blood-letting, the application of an abundant supply of leeches to the larynx, and the administration of calomel in large doses, with antimonials must be employed. If, notwithstanding the administration of these remedies, the difficulty in respiration

continue to increase, the windpipe must be opened before the lungs and brain become irretrievably engorged. It is no easy matter to determine when it is no longer prudent to trust to active antiphlogistic treatment, and when recourse should be had to operation; indeed, the determination of this point may be considered as one of the nicest questions in surgery. As a general rule it may be stated that if, notwithstanding the antiphlogistic means above indicated, the dyspnœa become gradually more urgent, and the paroxysms of spasmodic difficulty of breathing more frequent and severe, then no time should be lost in the performance of the operation, for however short a period the disease may have existed. I can truly say that I have seen several cases lost by delaying the performance of the operation, but never one by opening the windpipe too early. Indeed, if the opening be even made somewhat early, I do not think that much if any harm results, as the larynx is thereby set at ease; and, on the laryngitis being subdued by the continuance of proper treatment, the aperture, which has simply served as a breathing-hole, may be allowed to close by granulation.

Œdematous Laryngitis is seated chiefly, if not entirely, in the submucous areolar tissue, and frequently comes on in the course of chronic affections of the larynx. It may, however, be of a distinctly erysipelatous character, occurring as the result of exposure to infection, or to atmospheric vicissitudes. In fact, in many cases it appears to be at times epidemic, and in its pathological conditions resembles closely phlegmonous erysipelas of the part; the mucous membrane becoming red, pulpy, and swollen, and the areolar tissue lying beneath it infiltrated with semi-puriform plastic matter. In this form of the disease, the fauces are reddened, dusky, and swollen; there is much and early dyspnœa; the voice becomes hoarse, rough, and speedily extinct; deglutition becomes very difficult; and, on passing the finger over the back of the tongue, the epiglottis will be felt rigid and turgid. There may be some degree of tenderness about the larynx; but the local symptoms, which are less acute, are attended by a greater amount of dyspnœa than in the acute form of laryngitis. In œdematous laryngitis there is also a good deal of spasm associated with the local turgescence. The spasms sometimes come on early, and carry off the patient at once, and are very apt to be brought on by speaking or swallowing; but, as the disease advances, the dyspnœa may become more continuous, with great restlessness, a quick, small pulse, and convulsive breathing, the countenance being pale, sunken, and clammy, and the eye dull. Stupor at length supervenes, and speedily terminates in death.

The œdematous infiltration in this form of laryngitis is principally confined to the submucous areolar tissue around the epiglottis, at the margins of the glottis, and to that which lies at the back of the thyroid cartilage. In these situations the tissue is distended with sero-plastic fluid, of an opalescent appearance, so as almost completely to occlude the rima glottidis (Fig. 458). It is a pathological fact of much importance, that this effusion never extends below the true vocal cords, being limited at this point by the adhesion of the mucous membrane to the subjacent fibrous tissue, without the intervention of any areolar membrane.

Fig. 458.

Œdema of the glottis.

Diagnosis.—It is of great importance to make the diagnosis between the two forms of laryngitis. In the acute variety of the disease, antiphlogistic treatment is of great moment; in the œdematous form it is comparatively useless, for here effusion sets in early, and nothing is left for the surgeon but to open the air-passages, so as to give the patient breathing-room, whilst the disease is being subdued. In making the diagnosis, the epidemic character of the affection, the absence of much pain in the larynx, and the dusky-red and swollen fauces, point to the œdematous variety. Then, also, the effect of antiphlogistic treatment should be taken into account. If, after its active employment, no alleviation of the symptoms occur, it is only reasonable to suppose that the obstruction to breathing is owing rather to a purely mechanical obstacle than to simple inflammation.

Treatment.—The treatment of œdematous laryngitis must be antiphlogistic, though the constitution will not usually bear any very active measures. Leeching under the jaws and over the larynx, with the administration of antimonials and salines, will

disease from being confounded with an ordinary catarrh. This examination, however, requires to be properly made, so that a full view may be gained of all the parts engaged in the morbid action. This is best obtained by means of the laryngoscope, as already described.

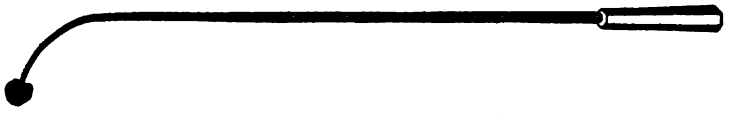
Treatment.—The treatment of the various chronic inflammations of the mucous membrane of the pharynx and larynx requires to be conducted by careful regulation of the general health, attention to climate, avoidance of exposure to cold, and attention to digestion; and especially by the local application of various astringent vegetable and metallic solutions.

In the milder forms of the disease, a saturated solution of tannin or glycerine, applied by means of a camel's-hair brush or a sponge-probang, will be found useful. In many cases the best results follow the inhalation of solutions of tannin or sulphate of zinc in a "pulverized" form, applied by means of the ordinary spray-douche, such as is used for procuring anæsthesia by the local application of ether. But of all these astringents none equals in value the *topical application of a solution of the nitrate of silver*, which may almost be looked upon as specific in these diseases.

The practice of treating chronic disease of the larynx by the application of a strong solution of the nitrate of silver is by no means of recent origin. Many years ago it was employed by Sir C. Bell; and before him Bretonneau applied the solution in these cases by means of a sponge attached to a piece of whalebone. Of late years this practice has been brought very prominently before the profession by Trousseau, and by the American surgeons, especially Horace Green and J. Warren.

Of the great value of this treatment in laryngeal diseases there can be no doubt. I believe it to be almost impossible to bring deeply seated and very chronic inflammatory or ulcerative affections of this part of the air-passages to a satisfactory termination by any other means. The mode of application that is the simplest and most effectual, consists in depressing the tongue with a proper spatula, and then passing a throat sponge, consisting of a small piece of this material firmly attached to a curved whalebone stick (Fig. 459), and saturated with a solution of nitrate of

Fig. 459.



Probang for applying nitrate of silver to the larynx.

silver, down to the parts that are diseased, so that the liquid may be applied to the whole of the affected surfaces. This solution should vary in strength from half a drachm to a drachm of the salt to an ounce of distilled water; most commonly, the latter strength will be most useful. This plan of treatment has been much practised of late years in this country, and with considerable success in a large number of cases. Some of its advocates, however, not content with curing in this way disease that is visibly seated in the throat, state that the morbid action extends down the trachea into the bronchi, and that it is necessary to follow it in these situations. They accordingly speak of passing the probang between and beyond the vocal cords, and of sponging and mopping out the interior of the larynx and the lower parts of the air-tube, and of applying the caustic solution to them, as if this were a proceeding that could be adopted with as little difficulty as passing the sponge into the nares. I cannot believe, however, that this practice, though commonly spoken about and professedly employed, is ever in reality carried out. Any one acquainted with the physiology of the larynx knows how acutely sensitive it is, and how it resists the introduction of any foreign body by the most violent spasmodic fits of coughing, in its normal state; and any surgeon who has seen the effects resulting from the fair and complete inhalation of a drop or two of solution of nitrate of silver in a morbid and irritable condition of this tube, must feel sure that no sponge saturated with a solution of this caustic could ever have been thrust down between and beyond the vocal cords.

On inquiring into the evidence on which is founded the doctrine of the passage of the sponge-probang through and beyond the vocal cords, I have failed to discover

that any of a positive character exists; and, so far as I can gather from the writings of its supporters, it would appear that the reasons from which it is inferred that the instrument thus passes may be arranged under the following heads:—

1. The sensations of the patient.
2. The sensations of the surgeon.
3. The analogy afforded by the introduction of tubes for the purpose of artificial respiration, and by the inhalation of foreign bodies.

These different conditions we must examine somewhat in detail.

1. *Sensations of the patient.*—The exquisite degree of sensibility possessed by the larynx need not be dwelt upon here. Porter, in his admirable work *on the surgical pathology of the larynx and trachea*, very justly says: "It (the larynx) is placed as an outwork to protect the important organ of respiration, and rejects vehemently, and with spasmodic violence, every substance that can by possibility prove offensive or injurious." Many years ago, Magendie showed that this was the most sensitive part of the respiratory tube; and in the year 1843 I published in the *Medical Gazette* a series of experiments, which demonstrated the same fact. Since then, I have had repeated opportunities of verifying the correctness of these observations in the human subject in cases of cut-throat and aërial fistula, in which, by means of probes introduced through the artificial opening, I have tested the extreme sensibility of the larynx as compared with other parts of the air-passages, and have often observed the spasmodic irritation and great distress suffered by the patient when its mucous membrane is touched from within; and this, even though the part is no longer subservient to the purposes of respiration, and the sensation of asphyxia is not experienced, which would otherwise be induced, and which would greatly aggravate the disease.

If a long bent probe, or a gum-elastic catheter, be passed over the back of the tongue, two classes of sensations will be elicited, according to the part that is touched. If the instrument be directed down the pharynx, and altogether behind the larynx, into the œsophagus, as in the introduction of the stomach-pump tube, the patient will experience some little distress, which is easily quieted. The face will become slightly congested, and the eyes, perhaps, somewhat suffused, with a disposition to cough, a slight feeling of choking, and some constriction about the chest. All these sensations, however, are transitory. These symptoms may be termed *pharyngeal*.

If, on the other hand, the probe or tube be bent *forwards*, so as to touch the lips of the glottis, and more particularly if an attempt be made to push it on into the larynx, then a widely different train of symptoms will be induced. The patient suffers extreme distress and anxiety; there are great sensation of constriction about the chest and throat, spasmodic difficulty in breathing, and an inability to speak; the countenance becomes much congested and livid; the eyes protrude, and stream with tears; he stands up, gropes wildly with his hands, and is pacified with great difficulty. As the attack goes off, there are deep, sobbing inspirations, and catches in the breathing. These symptoms, which are analogous to those induced by the irritation of the inside of the larynx through an aërial fistula, may be termed *laryngeal*.

The first class of symptoms is produced by the application of an irritant to the mucous membrane of the pharynx; the second, by irritation of the larynx. Their severity will, in a great measure, depend upon the nature of the irritant applied. They will necessarily be far more severe when a sponge soaked in a caustic solution is thrust down the throat, than when a smooth and unirritating gum-elastic tube is passed.

Both these classes of symptoms are commonly met with after the application of the throat-probang. When the *pharyngeal* symptoms occur, there can be little doubt that no sponge saturated with a strong solution of nitrate of silver has penetrated into the glottis. But is not the case different when the *laryngeal* symptoms are fully developed? Must these not, when existing in their full intensity, be taken as evidence of the introduction of the sponge-probang through the glottis? To this I have no hesitation in answering in the negative. I have repeatedly brought on the symptoms, in the most marked degree, without the use of a sponge at all, or the introduction of any solid body into the larynx. In fact, if a drop of a strong solution of the nitrate of silver be fairly *inspired* into the larynx, the most intense distress and appearance of impending asphyxia will be induced. I once saw this well

means of lint wrapped round a probe, to a syphilitic ulcer on the soft palate, altogether away from the larynx; a drop was accidentally inhaled, when the patient was suddenly seized with one of the most intense attacks of laryngeal spasm that I have ever seen; for a few moments she appeared to be about to die asphyxiated, and had all the laryngeal symptoms above described fully marked.

Thus, then, we may conclude that, when the *pharyngeal* symptoms exist alone, the sponge cannot have passed into the true air-passages; and that the *laryngeal* symptoms, however intense they may be, afford no evidence of more than the inhalation of a drop or two of the caustic solution into the glottis.

2. *Sensations of the surgeon.*—That little reliance can be placed on the mere sense of touch in many explorations of the mucous canals, is well known to surgeons. It often happens, for instance, that in the attempt to relieve retention of urine from enlarged prostate, the catheter is supposed to be in the bladder, when it has only reached the dilated sinus of the urethra: so also, in passing a bougie up the rectum, the instrument may appear to have entered the sigmoid flexure, when, in reality, it has curled back upon itself. Those practitioners, however, who believe in the possibility of passing the sponge-probang beyond the vocal cords, rely much on the sensations communicated by its passage through this narrow portion of the larynx. They say that, in passing the instrument to the proper depth, a certain sense of obstruction is felt; against this, which is believed to be seated in the vocal cords, the sponge is firmly pressed for a moment, when the obstacle yields, and the instrument passes onwards into the air-tubes. On the withdrawal of the probang, the same feeling of constriction is experienced by the sponge being drawn up against the cords. These sensations are undoubtedly experienced. I have many times felt them myself, and, had I judged by them alone, could have been almost certain that I had passed the instrument between and below the vocal cords, and this belief would have been strengthened by the circumstance that in many of the instances in which this constriction was felt the *laryngeal* symptoms were manifested. I soon found, however, that this was by no means uniformly the case, but that it not unfrequently happened that the *pharyngeal* symptoms only were induced; and that consequently, in accordance with what I believe to be the proper state of sensibility of the larynx, the interior of that tube could not have been traversed by the caustic sponge. Since, also, the same sensation was often experienced in the introduction of bougies and tubes into the œsophagus and stomach, it was clear that it could have nothing to do with their progress through the larynx; and I was led to conclude that it was occasioned by the passage of the instrument through that narrow portion of the end of the pharynx, or the beginning of the œsophagus, where the cartilages of the larynx, projecting backwards, gave rise to a certain amount of constriction, compressing the gullet, as it were, against the spine. Here the instrument meets with some obstruction, which is partly mechanical and partly occasioned by spasm of the constrictors of the pharynx; on this being overcome, it passes on with a sudden slip, again to meet with a degree of constriction on being withdrawn.

In numerous experiments on this point which I have made on the dead body, I have very frequently found that the instrument had passed into the œsophagus, when, from the sensation it gave, those who had introduced it felt confident that it had entered the air-passages. In fact, the shape of the sponge-probang, as it is always sold (Fig. 459), is such that it cannot be made to enter the larynx, and to pass beyond the vocal cords in the dead body, by means of those manipulations which are alone admissible in the living patient, and without the employment of a considerable degree of force. A probang with a short curve, such as those that are uniformly employed, has a natural tendency to take the direct passage, as it were, down the œsophagus, instead of turning forwards to enter the larynx. When the curve is much increased, as in an ordinary catheter, the sponge may, during life, be passed between the lips of the glottis; but it cannot even then be made to pass between and below the vocal cords, in consequence of the curve being too large to be admitted into the diameter of the trachea. The evidence of the New York Academy Commission fully warrants this statement; for the reporters remark that, notwithstanding the most persevering efforts with the whalebone slightly bent, as used by Green, and with patients who quietly submitted to the test of experiment, the results were entirely negative. In no instance did it enter the trachea. In two instances,

Fig. 462.

Operation of tracheotomy.

forwards by a sharp hook, and opened by pushing the point of the knife, with its back turned towards the sternum, between two of the rings, and cutting upwards through about three of them (Fig. 462). The tube must then be introduced, and retained by tapes round the neck.

The question as to the safety of the administration of chloroform in these operations often occurs. I believe that it may always be given safely except in cases of extreme syncopal asphyxia, where, as sensibility no longer exists, it is unnecessary. Laryngeal inflammation and obstruction is always associated with so much spasm, more particularly in children, that it will often be found that the patient respires more easily and fully whilst under the influence of chloroform than before he commenced its inhalation; and, as the anæsthesia materially facilitates the operation by doing away with his writhings and strugglings, I now invariably have recourse to it where I perform tracheotomy on children. In laryngotomy in the adult it does not appear to me to be necessary.

Difficulties.—This operation is often attended by extreme difficulty, and not unfrequently by much danger.

The difficulties occurring in tracheotomy are chiefly referable to four heads: 1. Difficulty in exposing the air-tube; 2. Profuse hemorrhage; 3. Difficulty in opening the air-passage; and 4. Trouble in introducing the trachea-tube.

1. The difficulty in *exposing the tube* increases greatly as the incisions approach the sternum, and is especially great in children and in stout short-necked persons.

There are three situations in which the trachea may be opened: either above, underneath, or below the isthmus of the thyroid body, which usually crosses the air-tube opposite its third or fourth ring. Above the isthmus, the trachea is comparatively superficial, and is not covered by any venous plexus, nor does any other source of difficulty present itself to the surgeon. Where the isthmus crosses the trachea, this tube is overlaid by a venous plexus as well as by the glandular structure. Below the thyroid gland, the air-tube is overlapped by the sterno-hyoid and sterno-thyroid muscles, and by the inferior thyroid veins, which are of large size, together with some tracheal branches from the inferior thyroid artery; and not unfrequently an irregular arterial branch ascends in this situation in front of the trachea to supply the thyroid body. The carotid arteries also are in close relation to the trachea on each side; and opposite the episternal notch it is crossed by the left carotid and by the innominata, which vessel has been seen by Macilwain to cross the tube at the very point where tracheotomy is usually performed. A glance at these important relations will suffice to indicate the difficulty that must, in many cases, occur in exposing and opening the trachea. This difficulty is greatly increased when the veins of the neck have become turgid in consequence of the pulmonic obstruction. It will also be seen that the trachea is less covered, and may consequently be much more readily reached above, than below the isthmus of the thyroid gland. Though some surgeons, as Velpeau, for instance, have recommended the opening to be made in the lower part of the tube, no advantage whatever is gained by so doing, whilst the difficulties of the operation are very seriously increased; and in practice it is almost invariably opened at its upper part, usually between the second and third or third and fourth rings, though the incision may, if necessary, be carried downwards as low as, or even through the isthmus.

2. The *hemorrhage* may occur either from arteries, from veins, or from the thyroid gland. Arterial hemorrhage is less frequent and troublesome than the bleeding from other sources. When it occurs, it chiefly happens from the wound of some anomalous branch, or from that of the small tracheal vessels. Desault has, however, mentioned a fatal case, in which death arose from a wound of the carotid. The arterial anastomosis of the isthmus of the thyroid body may, if this part be enlarged, occasion some difficulty in the performance of the operation; but the main source

which always exists at the lower angle of the wound, between the trachea and t
deep fascia of the neck. This error is not only embarrassing in the highest de
to the surgeon, but dangerous to the patient by the delay it occasions, by the
pression exercised on the trachea below the opening into it, and by the suc
blood into the aperture in the air-tube. It is best avoided by expanding the
opening with the dilator (Fig. 467), and passing the tube between the blad
instrument. In the first instance, a tube of a conical shape should be em
it is not only introduced more readily than a cylindrical one, but fills u
the aperture in the trachea, so as to prevent the draining of blood in
In passing the tube into the trachea some difficulty may be experie
the elasticity of the sides of the incision in the windpipe, in conse
one of them is apt to be doubled in under the end of the instrume
avoided by the use of Fuller's bivalve tube introduced closed (F
expanded by slipping a canula into it (Fig. 466); or one side

Fig. 465.

Bivalve tube, closed.

Fig. 466.

Bivalve tube with canu

trachea may be held aside with the forcep
under the other. If the rings of the tra
tube may most conveniently be introd
the trachea forceps (Fig. 467), and th
Some surgeons prefer, instead of
forceps, or with a trocar carrying
is then left in the air-passages; th
respects useful, do not appear to
in children, as the scalpel and t
Tracheotomy in children is
The difficulty of the operatio
children from the shortness
the quantity of granular a
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When the

nary signs of local inflammation, terminating in circumscribed suppuration. The *treatment* consists in the application of warm poultices made with lead lotion, and lancing the part early. In doing this, care should be taken that the cut be made from the centre of the nipple towards the circumference of the areola, so as not to divide the lacteal ducts.

Inflammation of the Breast, which as it generally terminates in suppuration, is usually called *milk abscess*, may occur in three situations; 1, in the subcutaneous areolar tissue, *supramammary abscess;* 2, in the bed of areolar tissue in which the mammary gland is lodged, *submammary abscess;* and 3, in the gland itself, *mammary abscess.*

1. *Inflammation, followed by abscess of the subcutaneous areolar tissue of the breast*, though commonly occurring during lactation, is more frequently met with than any other form of inflammation in this region at other periods of life, more particularly about the age of puberty. Its symptoms are those of simple phlegmonous inflammation, differing in no way from abscess of this kind in other situations, except that it is always distinctly circumscribed.

2. *Inflammation in the areolar plane between the mamma and the pectoral muscle* diffuses itself over the whole of the areolar layer, and almost invariably runs into abscess with considerable rapidity, giving rise to great pain in this situation of a deep, heavy, and throbbing character, much increased by moving the arm and shoulder, and attended by swelling, œdema, and a slight red blush upon the skin. The breast becomes prominent, is conical and projecting, the whole organ being pushed forwards by the pressure from behind; it is not readily movable on the pectoral muscles, and the subcutaneous veins become engorged, and at last abscess forms. It is not always easy in these cases to determine whether suppuration has taken place or not, the depth at which matter forms rendering it impossible in the early stages to detect fluctuation until it approaches the surface; its presence may, however, be suspected on the occurrence of deep-seated throbbing pain, œdema, and some superficial redness. The abscess at last points at some part of the margin of the gland, usually at its lower and outer side, where the matter seems to gravitate; after a time, however, it will commonly appear at other points of the circumference of the gland, beyond which it always extends, though it seldom, if ever, perforates the structure. I have, in more than one instance, seen a series of four or five apertures, forming a large circle round the margin of the gland. It very commonly happens that the apertures through which the pus discharges itself in these situations, degenerate into fistulous canals, by no means easily closed.

3. *Inflammation of the mammary gland* itself is not of such frequent occurrence as either of the other forms of abscess. When the whole of the organ is affected, it gives rise to great swelling of the breast, with severe aching and lancinating pain, and much constitutional disturbance, usually of an irritative type. Not unfrequently one lobule only of the gland becomes inflamed; and then the local signs are proportionately limited, and occasionally cease. As Velpeau has pointed out, one lobule after another may become inflamed, so that a succession of abscesses forms in different parts of the gland. As the inflammation advances to suppuration, the skin is reddened, assumes a dusky hue, becomes glazed, has a peculiar greasy appearance, and pits on pressure. When matter has formed, the tension of the superficial parts, with œdema and perhaps deep-seated fluctuation, determines its presence.

Treatment.—In the treatment of inflammation and abscess of the breast occurring during lactation, it must be borne in mind that we have not a sthenic inflammatory condition to deal with, but that the disease almost invariably happens in pale, delicate women, commonly of a strumous habit, and weakened by recent parturition; indeed, the affection appears to be rather an inflammation of an irritative and congestive, than of a sthenic character. It is therefore obvious that antiphlogistic means of an active nature are not admissible; and the best plan of treatment appears to consist in keeping up the strength of the patient by proper constitutional support at the same time that the local inflammation is checked by topical antiphlogistic measures. The first thing to be done is to prevent the occurrence of suppuration; if this can be accomplished, which is, however, rarely the case, much will be gained. In order to effect this, the breast should be supported in a sling, so as to lessen congestion in it; and the arm at the same time should be fixed to the side, in order to prevent traction of the pectorals and movement of the submammary areolar tissue. If the patient's strength be good, leeches may be applied; in the majority

obscurity attending the diagnosis, and the fact of their commonly being mistaken for cancerous growths.

The most important of these, perhaps, is a *recurrent fibrous* tumor, which shows a remarkable tendency to return after removal. This it may do many—so often as eight or ten—times.

Sir A. Cooper describes a *scrofulous tumor* of the breast; the precise nature of which is not very apparent from the account given by that surgeon. It is not improbable, however, that it is of tuberculous character; and Velpeau states that he has found tubercle occurring in the breast in two forms: in the first, primarily deposited in the skin and subcutaneous cellular tissue; and in the other, as a fibro-tuberculous affection of the gland itself.

Hydatids of the breast are of rare occurrence, and have been principally described by Sir A. Cooper; cases have also been related by Gräfe and others. These hydatid tumors are so excessively rare and obscure, that their true nature would not, in all probability, be suspected until after removal. They present the ordinary characters of deeply seated cysts, with fluctuation and some induration round the globular swelling, and an absence of pain. In such a case, an incision into the tumor will cause the escape of the acephalocysts, and the ultimate suppuration of the cavity in which they lodged, which will gradually cicatrize.

In some rare cases, tumors containing *fœtal remains* have been met with in the breast; these, however, are rather matters of pathological curiosity than of practical importance.

MALIGNANT TUMORS OF THE BREAST.

All the various forms of cancer have been met with in the breast; scirrhus, however, occurs with far greater frequency than any of the other varieties. Occasionally the encephaloid form of the disease is met with, but colloid very rarely occurs. There is, however, a preparation in the University College Museum illustrating the disease, and I have once removed a very large colloid tumor from this region. Cancer of the breast, whatever form it assume, is invariably primary: it may affect one lobe only, or be infiltrated into the whole gland; and it may commence in the nipple or in the skin covering the breast. Most frequently one side only is affected; but in some cases both mammary glands are implicated.

Scirrhus.—Scirrhus is the form of cancer which is commonly met with in the breast. It may occur in several ways; either affecting the nipple, implicating the skin, being deposited in the form of an intra-mammary tumor; or infiltrating the whole substance of the organ. It most commonly commences as a circumscribed tumor of small size, at first perhaps smooth and round, hard and indolent in its character, with little or no pain; it is readily movable, may be situated in one lobe, and is attached perhaps to the rest of the gland by a distinct pedicle. As it increases in size, it becomes hard, knobbed, and irregular, perhaps presenting a finely granular feel, and becoming fixed to the gland and subjacent parts. When the disease begins as scirrhous infiltration of the breast, the mass is from the first hard, rugged, irregular, nodulated, and heavy; often somewhat square in shape, and early accompanied by adhesions to subjacent parts. In other cases, the development of the scirrhous mass is accompanied by a corresponding atrophy of the mammary gland, which becomes shrivelled and disappears entirely. In some instances, rather large cysts may form in connection with the scirrhous mass. In a woman, whose breast I once removed for what was supposed to be cystic sarcoma, but which proved after the operation to be a scirrhous tumor, the mass contained several cysts as large as cherries, filled with dark or greenish fluid, and projecting from its surface; and in a lady under my care for scirrhus of the breast, a tumor as large as a pigeon's egg, containing sanguinolent fluid, formed on the surface of the tumor.

As the swelling increases in size, it has a tendency to be more fixed to the subjacent parts, becoming adherent to the pectoral muscles and incorporated with the areolar tissue at the border of the axilla. The tumor also begins to form a distinct external projection, and becomes more irregular in shape; it is the seat of severe pain, more particularly at night; and is usually covered by a plexus of blue and dilated veins. The ordinary symptoms of cancerous cachexy now appear, and the disease then makes still more rapid progress.

The tumor may in some cases remain for a great length of time without impli-

cating the *skin;* but most commonly, after it has existed for a few months, this tissue becomes more or less involved in the morbid action. Instead of being loose and movable over the surface of the cancer, it will be found, on being pinched up between the fingers, to dimple at one part, where it may be felt to be attached by a kind of cord-like process to the tumor beneath it. After a time, that portion of the skin which first became fixed in this way acquires a reddish or purplish color, and is covered with thin, scaly, epidermic desquamations, and becomes permeated by a number of small ramifying vessels. A crack or fissure eventually forms in this; a small exudation of a mucous fluid takes place, which dries into a scab; under this, ulcerative action sets in, which speedily assumes the ordinary characters of a scirrhous ulcer, having hard, elevated, and everted edges, a grayish-green or foul surface, and discharging a quantity of very fetid pus. In some cases ulceration may take place at several points, and thus the whole surface of the breast becomes converted into one immense chasm, which may even extend up into the axilla.

The skin, when affected, often assumes a red, glazed, hard, and brawny character, being shining, and as if greasy upon the surface, having its pores enlarged, and enveloping the side of the chest in a kind of stiff solid casing, attended usually by much pain, considerable œdema of the arm, and an aggravated form of constitutional cachexy: ulceration at last takes place in this hardened mass, and then speedily destroys the patient. In other cases, the cancerous development seems to develop primarily, and to expend its energy chiefly upon the cutaneous structures. The tumor of the gland is small, atrophic, and implicates the nipple. The cancerous infiltration rapidly spreads into the surrounding integument, which becomes early contaminated, assuming a hard, leathery character, or feeling brawny and infiltrated; often without discoloration, but presenting a hypertrophied appearance, the pores being enlarged, and the interspaces between them increased. In other cases the infiltrated skin assumes a brownish or purplish color, and is covered by rough desquamating crusts, so as to resemble the bark of an old tree. This diseased state of the integuments will extend very widely, without ulceration or further development of the tumor situated in the gland. I have in this way seen the integuments of the whole front of the chest, from the clavicles to below the mammæ, and from one axilla to the other, infiltrated, hard, and leathery, of a brownish-red color, forming a stiff cuirass, as it were, but without ulceration. This condition is very chronic; and it is remarkable that in it the axillary glands are not infiltrated, or the constitution rendered cachectic, at nearly so early a period as when the disease primarily originates in the mammary gland, and secondarily involves the skin.

Another way in which the skin becomes involved primarily, is by the formation of a scirrhous tubercle or nodule in it, usually towards the outer or axillary border of the mamma. From this the disease gradually infiltrates inwards, implicating the gland in a secondary manner, and usually but to a limited extent.

The *pain* is in many cases but trifling in the early stages of the affection; so much so, indeed, that it is the tumor, often accidentally noticed, that first excites alarm; as it increases, however, the suffering becomes severe, more particularly at night, is greatly aggravated by handling the diseased mass, and chiefly extends up to the shoulder and down the arm. The pain usually becomes most severe about the time when the skin is first implicated; but as the cutaneous infiltration goes on, it gradually lessens, owing probably to the destruction of the cutaneous nerves.

Retraction of the nipple commonly commences about the same time that the skin is implicated; it appears to be owing to the glandular substance becoming involved in the mass of the tumor, and thus giving rise to shortening of the lacteal ducts; in consequence of which, by the projection forward of the general mass of the breast, the nipple appears to become completely buried. This sign has received more importance than it deserves in connection with cancer, as it does not occur in all cases of malignant disease, and is occasionally met with in simple mammary tumors.

The *axillary glands* usually become enlarged early in the disease, and may attain a greater size than that of the original tumor; and on close examination a kind of indurated cord may be felt extending in the course of the absorbents, from the edge of the pectoral muscle to the axilla. After a time the supra-clavicular or sub-clavicular glands may likewise become implicated. In fact the whole of the glandular structures in the vicinity of the shoulder undergo cancerous infiltration. When this

is the case, the pressure that is exercised upon the axillary vein may occasion œdema of the arm and hand. The glandular infiltration usually increases rapidly after the skin has become implicated. In some cases, scirrhus of the axillary glands is the primary disease; and in other instances it happens that, when the glands become affected, the chief virulence of the disease appears to expend itself upon them. The tumor of the breast ceases to enlarge, or may even atrophy, whilst the secondary glandular deposits in the axilla become greatly developed.

As the scirrhus extends, it may gradually affect the subjacent muscles, cellular tissue, the ribs, and at last the pleura, giving rise eventually to hydrothorax or secondary visceral deposits. In many instances, however, the disease proves fatal by the induction of exhaustion. The constitutional cachexy is in many cases not very distinctly marked, until after the skin has become involved; but then it rapidly increases, more especially when ulceration takes place. Indeed, the cancerous degeneration of the skin may be looked upon as an epoch of peculiar importance in scirrhus of the breast, as it is at this period that the pain increases, that the lymphatic system becomes infected, and that the constitution becomes distinctly poisoned.

Duration.—The duration of life after the occurrence of scirrhus of the breast varies greatly; so much so, that the disease may be considered as assuming an acute and a chronic form. The acute variety principally occurs in ruddy and plethoric women, and commonly proves fatal in a few months. In those who are of a more feeble and delicate constitution, the disease, as a general rule, takes a slower course. Sir A. Cooper states that the disease, on an average, is from two to three years in growing, and from six months to two years in destroying life after being fully formed. In this estimate, which is probably correct, Walshe agrees; so that the average duration of life in cancer of the breast would probably be about three years. As a general rule, the progress of scirrhus is slower in old people, in whom it occasionally gives rise to a kind of atrophy of the breast, with shrinking and induration of the tumor. There are many instances on record, however, in which cancer of the breast has existed for a far longer period than has just been mentioned; for ten, twelve, or even, as in a case related by Sir B. Brodie, for twenty-five years.

Pathological structure.—After removal, scirrhus of the mamma presents considerable variety in appearance. In the majority of instances it occurs as a peculiarly hard, knobbed, and irregular mass, creaking under the knife when cut, and presenting on section a grayish or bluish-gray, semi-transparent surface, traversed in various directions by bands of a more opaque character, and exuding on pressure a thin reddish juice. In many instances, masses of an opaque appearance and yellowish tint may be seen in the midst of the tumor. These, which look like tuberculous deposits, consist in reality of fatty degeneration of the scirrhous structure. In other cases again, on pressing the tumor, small drops of a thick creamy fluid will appear to exude at various points. This appears to be the inspissated and altered secretion of the gland retained in the ducts. Cysts are occasionally, though rarely, met with in scirrhus of the breast; these are usually small, and contain clear fluid, being deeply imbedded in the substance of the tumor; in other cases they may be large and globular, and filled with a bloody or dark-green liquid. The microscopical characters of scirrhus of the breast are such as are represented in Fig. 199.

Encephaloid.—Encephaloid of the mammary region and gland is by no means of such common occurrence as scirrhus, yet all the varieties of this form of cancer have been met with in the breast; and fungus hæmatodes has been seen to spring from the bottom of cystoid growths previously developed in this region. Encephaloid of the breast may sometimes acquire a considerable size; thus, Cruveilhier relates a case in which the tumor weighed nearly twelve pounds. The structure of this disease does not differ from that of the same affections in other situations; both the hard and the soft varieties may be met with, and in some advanced cases the true fungous growths occur.

Encephaloid usually begins deeply in the substance of the breast, though sometimes, but more rarely, at a little distance from the gland, as a soft globular tumor, which rapidly increases in bulk; the integuments covering it are not at first adherent, but are usually pushed before it, and speedily become permeated by a largely ramified network of veins. In some cases I have seen the integuments, early in the disease, œdematous and inflamed, so as to mask the subjacent tumor. The mass at first feels as if composed of several soft and rounded tumors, which communicate an obscurely fluctuating sensation, perhaps causing the surgeon to mistake the

of a complete cure, the operation holds out the prospect of an average gain of nearly two years of life.

There is, however, another point of view from which these operations may be considered; for, even if they do not prolong life, they may greatly improve the patient's condition, and place her in a state of comparative comfort during the remainder of her existence. Thus, she may be suffering so much pain from the local affection, or, if it be ulcerated, may be so much affected by the fetor of the discharges, that she may be placed in a position of far greater comfort by having the local source of disease and irritation removed; and though she die eventually of cancer, it may be with much less suffering to herself and others for her to be carried off by secondary deposits in the lungs or liver, than to be worn out by the external affection.

In considering the propriety of operating in cancer of the breast, it is of the utmost importance to distinguish those cases in which the operation may possibly be the means of preserving or prolonging life, from those in which there is no prospect of its being of any service, or in which indeed it must inevitably hasten the patient's death. Whatever the value of statistics may be in determining the question, whether in cases of cancer of the breast generally the operation will effect a cure or prolong life, they are not equally valuable in their application to individual cases. When a surgeon is called for his opinion respecting the propriety of amputating the breast of the patient before him, it is not sufficient for him to be able to state what the general result of the operation may be, but he must be able to satisfy himself whether the particular instance under consideration may not be one of those cases, exceptional perhaps, in which there is a fair probability of extirpating the disease entirely from the system, or at all events of prolonging the patient's existence. In order to do this, it is necessary to endeavor to lay down some rules that may guide us in selecting those cases in which the operation may be advantageously done, and in setting aside others in which we know that it will almost to a certainty hasten the patient's death. And, indeed, it is the absence of all such considerations in general statistical investigations into the results of operation for cancer, that deprives them of much of their value as guides in actual practice.

Though nothing can be more unsurgical or improper than the indiscriminate extirpation of all cancerous tumors of the breast from every patient who may present herself in whatever stage of the disease; and though such a practice would doubtless be followed by fully as disastrous results as those that occurred to Macfarlane, Benedict, and others; yet there can be little doubt that a surgeon who would employ a certain principle of selection, would obtain a very different and a far more successful result in his practice. Sir B. Brodie has very clearly and succinctly pointed out the most important circumstances by which the question as to the propriety of operating in these cases should be determined. Before doing so, he very justly dwells on the fact that in many cases the operation may fail, and the disease speedily recur, through the negligence of the surgeon in leaving portions of the gland, slices of the tumor, or contaminated tissues, and that thus the operation may receive discredit for what is in reality the fault of the surgeon who has performed it.

With reference to operation, cancerous diseases of the breast may be divided into three classes: 1. Those in which it is the duty of the surgeon to discountenance excision; 2. Those in which operation is of doubtful expediency; and 3. Those in which it is the duty of the surgeon to recommend it.

1. *Cases unfit for operation.*—In this class we may include the following conditions: *a.* Those cases in which there is strongly marked constitutional cachexy; *b.* When both breasts are involved; *c.* When there are secondary deposits in internal organs; *d.* When the glands under, and especially above, the clavicle are much enlarged; *e.* If the tumor be adherent to the ribs and intercostal muscles; *f.* When the skin is hard, brawny, and infiltrated, of a reddish-brown color, having a hard, leathery feel, or a greasy, glazed appearance; *g.* If the tumor be rapidly growing in a patient with a strong hereditary taint; *h.* If it be extensively ulcerated and fungating.

2. *Doubtful cases.*—*a.* If the patient be aged, weak, or anæmic, and the tumor large, it is seldom expedient to operate, as the shock may destroy life. *b.* When

the skin is merely dimpled in by a kind of pedicle passing from the tumor to its under surface, an operation may be performed, unless other circumstances should contraindicate it; but in such cases it is necessary widely to excise the integument surrounding the attached point. The cancer-cells, as I have more than once had occasion to observe, will be found to have diffused themselves extensively through the neighboring skin, which, to the naked eye and to the touch, has a perfectly healthy appearance, the tumor being surrounded by a kind of halo or atmosphere of cancer-infiltration. *c.* When there is but moderate enlargement of the axillary glands, which are so situated as to admit of removal, the operation may be performed. *d.* When the cancer is ulcerated, it is seldom proper to operate; but, if all other conditions be favorable, this even need not in some special cases be a bar. As Sir B. Brodie has pointed out, the patient's existence may sometimes in these cases be prolonged, and her comfort materially increased, by removing the diseased and ulcerated mass.

3. *Cases favorable for operation.*—The exclusion of all the cases that fall under the preceding categories will necessarily limit very materially those in which an operation may be undertaken; it can, however, be performed with every prospect of its being advantageous to the patient, if the tumor be of moderate size, slow or nearly stationary in its growth, unconnected with or at least merely attached by a pedicle to the skin, pretty distinctly circumscribed, movable on the subjacent parts, and not complicated by enlarged glands in the axilla or elsewhere. The patient has an especially good prospect of recovery, according to Brodie, if the disease be seated in the nipple.

When once a tumor of the breast has been ascertained to be of cancerous character, the sooner it is removed the better, unless one of the special reasons adverse to operation that have just been adverted to should exist. I cannot conceive that any good can come of delay in these cases. The disease (for reasons stated at pp. 492, 493) appears in the early stages often to be entirely local: there is no evidence of constitutional infection, but if the operation be delayed the skin speedily becomes implicated, the axillary glands enlarge, and cancerous cachexy sets in. As a general rule, it may be stated that in all cases of cancer of the breast the whole of that organ ought to be freely removed, especial care being taken that no slices of mammary structure be left behind; and after removal the under surface and edges of the gland ought to be carefully examined, with the view of seeing that the extirpation has been complete. When the cancer is infiltrated, the whole of the breast and the surrounding cellulo-adipose structures must be very freely removed, as there is often a halo of cancer-deposit around the morbid mass, in tissues apparently healthy. It may happen that the tumor, especially if scirrhous, is apparently isolated, and situated at one border of the gland, scarcely, if at all, connected with that structure. Here the question will arise, as to whether the whole of the organ ought to be removed or not. In determining this we must, I think, be guided by the position of the scirrhous mass and the size of the breast. The cancer-infiltration proceeds in the course of the lymphatic vessels. If the cancer be situated towards the sternal or under aspect, however isolated it may appear, it will be found that the mammary gland will certainly have become infiltrated, lying as it does between the morbid mass and the lymphatics. When, however, the tumor is seated at the upper or outer border of the gland; when it appears to be detached from the breast, lying rather in the axilla or below the clavicle than in connection with the gland; when the breast itself is very large and fat, but healthy to the feel, without hardness or retraction of the nipple; when there is no sign whatever of deep infiltration of the breast—it may then be a question whether it will not be more prudent to extirpate the tumor alone, with the adipose bed in which it lies, and a deep slice of the adjoining mammary gland, than to perform the more serious operation of removing the whole of the breast. In determining this point we must, I think, be guided by the situation of the tumor, the feel of the breast, and the size of that organ. If the tumor be distinctly axillary, if the breast feel perfectly soft and healthy, with the nipple projecting, there is no reason to fear infiltration by cancer of the central and sternal portions of the mammary gland. I have found on careful microscopical examination of breasts removed for scirrhus at the axillary borders that these parts of the gland were entirely free from all sign of disease. If the mamma be small and shrunken the whole may be removed without any increase of danger; if it be of very large size, the surgeon best consults the patient's safety by simply removing the tumor

be thin, so that the operation is not a very severe one, the extirpation of the whole of the breast ought certainly to be practised. However widely the parts are removed, the line of incision usually comes together readily and evenly, owing to the laxity of the integuments in the mammary region.

I have observed in those cases in which it becomes necessary to extirpate tumors of the mammary region, without removal of the gland, that erysipelas has more frequently followed the operation than when the gland, being affected, has required removal.

Return of cancer after operation may take place in three situations: in the cicatrix of the part operated upon; in the neighboring lymphatic glands; or in some internal organ. When cancer recurs in the neighborhood of the previously affected part, it is probably owing to the cancer-cells having diffused themselves so widely into the skin, the subcutaneous areolar tissue, and muscles, or neighboring lymphatic glands, that after the removal of the tumor these cells become the germs of new growths. In these circumstances, it may recur in the cicatrix and then implicate the glands; or in the glands without the cicatrix having been previously affected. In local relapse of this kind, it often happens that the disease, so reproduced, runs its course more rapidly than if no operation had been performed; the increased action set up in the part during the healing process appearing to give augmented force to the reproductive energy of the cancerous growth. In some cases it even returns in the cicatrix before cicatrization is completed, the ulcerated surface then assuming the ordinary character of the cancerous ulcer. In other cases, the cicatrix, some weeks or months after it is fully formed, assumes a dusky red or purplish tinge, becoming hard, stony, and nodulated at points; these nodules being round or oval, often very numerous, and varying in size from a pin's-head to a pigeon's egg, studding the whole length and breadth of the cicatrix, and at last running into true cancerous ulceration. In such circumstances the only hope of prolonging the patient's life lies in the speedy excision of the whole of the diseased structures, or their extirpation by caustics, provided there be no deep affection of the glands, nor evidence of internal secondary deposit. But if the axillary glands be much enlarged, either alone or together, with recurrent disease in the cicatrix, or if there be any sign of internal cancer, further operations will be improper.

Amputation of the Breast.—The operation for the removal of a breast, whether affected with cancer or with other disease, may be performed in the following way: The patient should lie upon a table, with the arm hanging over the side, tied down or held by an assistant. If the tumor be large, and the loss of blood a matter of much consequence, another assistant should compress the subclavian artery on the first rib. The hemorrhage will, however, depend more on the nature than on the size of the tumor. In all cancerous tumors, but especially in the encephaloid, it is considerable, and from many enlarged vessels. In simple tumors, even of very large size, it is often trivial. I have removed a simple tumor of the breast of many pounds weight, and only had to tie one spouting vessel. Indeed, nothing indicates more conclusively the enormous vegetative activity of cancerous tumors, and the great drain they must exercise upon the system generally, than the large size and great number of their supplying arteries, compared with those sent to a simple tumor many times larger than a malignant one. If the veins about the part be much dilated, measures should be taken to arrest the flow of blood from them, as it may sometimes be dangerously profuse; indeed, South relates the case of a patient who died from this cause during the operation.

The direction of the incisions through the integuments is varied by different surgeons; some prefer a transverse, others a perpendicular one. I think that no definite plan should be followed, but the direction of the cut made to vary according to the situation and size of the tumor, and the amount of integument that requires removal. In all cases, the nipple should be included. In ordinary cases, as a general rule, I prefer an oblique incision following the course of the fibres of the great pectoral muscle; as it enables the surgeon, if necessary, to extend the cut into the axilla for the removal of enlarged glands, and, after cicatrization, allows the movements of the arm without undue traction. An oblique elliptical incision, of sufficient length, may thus be made, first below, and next above the nipple, so as

this way it not unfrequently happens that the herniæ of infants become radically cured; the same result, however, seldom occurs at a more advanced period of life. In order that compression may succeed in this way, it is necessary that it should not only be applied to the external aperture through which the rupture escapes, but to the whole of the canal. It must also be continued for a very considerable time, at least a year or two, and care should be taken that during the treatment the rupture is not allowed to descend; every time it comes down, any good that may have been derived is necessarily done away with, and the treatment has to begin, as it were, anew. After the cure is supposed to have been effected in this way, the application of the truss must be continued for a very considerable length of time, lest by any unfortunate movement the rupture descend again.

The operations that have been devised for the radical cure of hernia are all founded on one of two principles, viz., the excitation of such an amount of peritonitis in the sac, or its neck, as to cure its obliteration; or the plugging of the hernial aperture by invagination of the integumental tissues.

If the accomplishment of these conditions would always prevent the recurrence of the rupture, the radical cure might frequently be undertaken. But it is impossible to look upon the agglutination of the walls of the sac, or the closure of the abdominal aperture, as the sole conditions required. To accomplish the radical cure, it would be necessary in many cases to effect changes in the shape and connections of the abdominal contents, to alter the size of the abdominal cavity, and indeed to modify in various ways many conditions independent of those immediately connected with the hernial protrusion. Many of the means of radical cure, by which obliteration of the interior of the sac or of its neck is sought to be effected by the application of sutures or ligatures, by the introduction of caustics, by excision, scarification, puncture, or injection with tincture of iodine, are attended with so much danger from peritonitis, and are so seldom followed by any good results, that their consideration need not detain us here, the more so as they are universally abandoned by surgeons of the present day.

The operations that are now practised for the radical cure of hernia are conducted on two principles, however much they may be varied in their details by the ingenuity of particular surgeons.

The first principle of treatment consists of invaginating simply a portion of the scrotum, and fixing it in the inguinal canal, where it becomes adherent, and so occludes the aperture of exit. Of this kind of operation Wutzer's is the best example. The second principle of treatment consist in excising a portion of the integumental structures, and then by means of sutures attaching these and the deeper parts together, and thus leading to the consolidation of the canal. Of this, Wood's operation is the best example. The following are the details of these procedures.

Wutzer's operation.—The late C. W. Wutzer, of Bonn, adopted a plan of radically curing reducible inguinal herniæ, combining the two principles on which the older operations were founded, viz., the agglutination of the neck of the hernial sac by the excitation of inflammation in it, and the closure of the inguinal canal by the invagination of the scrotum: and he carried out these objects in a safer and more successful manner than by any of the methods previously employed. His plan of treatment consists in introducing a plug of the scrotum into the inguinal canal, and fixing it there by exciting adhesive inflammation in the neck of the sac. The details of the operation are as follow. The patient lying on his back, and the hernia being reduced, the surgeon pushes his index-finger up the inguinal canal as high as the internal ring, carrying before it a cone of the scrotal tissues; a box-wood hollow cylinder, about four inches long (Fig. 480, C), well oiled, is then pushed up as the finger is withdrawn, so as to occupy its place in the inguinal canal. Along the interior of this cylinder a flexible steel needle, gilt, (A), fixed in a movable handle, is then pushed, so as to traverse the invaginated scrotum, the hernial sac, and the anterior abdominal wall, through which its point is caused to protrude. A concave box-wood case (B) is then passed over the projecting point of the needle, and fixed by the other end by a screw apparatus to the cylinder (C), so as to compress the inclosed tissues. The apparatus so fixed is left *in situ* for

certain degree of impulse on coughing. There is no sign of peritonitis. There may be constipation; but there is no vomiting, or, if there be any, it is simply mucous and bilious, consisting of the contents of the stomach. The speedy restoration of the intestinal action, by the treatment already indicated as proper in these cases, will remove any doubt as to the nature of the affection.

2. *Inflamed irreducible hernia.*—Here there is great tenderness and pain in the tumor, with pyrexia, and some general peritonitis, but there is no vomiting; or, if the patient have vomited once or twice, he does not continue to do so with the same degree of violence, or in the same quantity, as he would if the peritonitis were the result of strangulation. Again, the constipation is not absolute and entire, but flatus and liquid feces will usually pass.

3. *General peritonitis conjoined with hernia.*—Here the diagnosis is often extremely difficult, especially if the hernia be an irreducible one. In these cases, however, it will be observed that the peritonitis may be most intense at a distance from the sac; that there will be little or no vomiting, or, if there be, that it is simply of mucus and the contents of the stomach; and that the constipation is by no means obstinate or insurmountable by ordinary means.

4. In *double hernia*, one tumor may be strangulated and the other not, though irreducible. In these circumstances, it may at first be a little difficult to determine which one is the seat of constriction. This, however, may be ascertained by observing greater tension and tenderness about the neck of the strangulated than of the unconstricted hernia.

5. The coexistence of *early pregnancy*, or a *threatened miscarriage*, may obscure the diagnosis, the surgeon possibly being in doubt whether the vomiting is dependent on the state of the uterus or on the strangulation of the hernia. Here it may be stated generally that the vomiting of pregnancy never becomes stercoraceous; that constipation, if it exist, does not resist the action of aperients or enemata; and that the local signs of strangulation are usually well marked.

Besides these various conditions of hernia, which may be confounded with strangulation, there are other tumors which may be mistaken for this disease: but these we shall have to consider when speaking of the special forms of hernia.

Treatment.—The treatment of strangulated hernia is one of the most important subjects in surgery. The object sought to be accomplished is the removal of the constriction from the strangled hernial tumor. This is effected either by the reduction of its contents by taxis, or by the division of the stricture.

Taxis.—The reduction of the hernia is effected by the employment of the taxis, by which is meant the various manual procedures employed in putting the rupture back. The taxis, when properly performed, is seldom attended by any serious consequences to the patient. I have never known it followed by death; and out of 293 cases of hernia reported by Luke, as having been reduced by the taxis in the London Hospital, none died. It is not unfrequently followed, however, by a rather sharp attack of peritonitis, which might probably, in some instances, prove fatal; in one instance, I have seen it followed by very abundant hemorrhage from the bowel, probably owing to the rupture of some of the congested vessels of the strangled portion of the gut. In using the taxis, great care should in all cases be employed, and no undue force should ever be had recourse to. No good can ever be effected by violence: the resistance of the ring cannot be overcome by forcible pressure; and a vast deal of harm may be done by squeezing against it the tender and inflamed gut, causing this to overlap, and thus to be bruised, or even perhaps torn. The taxis should not be prolonged beyond half an hour; if it be properly employed for this time, the hernia, if reducible, will probably go back. If it be applied, as it often is very improperly, for a lengthened period, and by several surgeons in succession, the protruded part becomes ecchymosed, irritated, and disposed to inflammation; and the chances of recovery after a subsequent operation are much lessened. When the parts are much inflamed, the taxis should be employed with great caution; and, if it have been fairly and fully used by another surgeon, it is better not to repeat it. When gangrene has occurred, the taxis should never be employed; as the putting back of the mortified gut into the abdomen would be followed by extravasation of feces and fatal peritonitis.

In using the taxis, it should be borne in mind that there are two obstacles to over-

come; the resistance of the parts around the ring, and the bulk of the tumor. The first may be somewhat lessened by relaxing the abdominal muscles, and consequently diminishing the tension exercised upon the tendinous apertures and fasciæ of the groin. In order to effect this, the patient should be placed in a proper position, the body being bent forwards, the thigh abducted, and semi-flexed upon the abdomen; the surgeon may then, by employing steady pressure on the tumor, endeavor to squeeze out some of the flatus from the strangled portion of intestine, and thus to effect its reduction. In doing this, the neck of the sac should be steadied by the fingers of the left hand; whilst, with the right spread over the tumor, the surgeon endeavors to push it backwards, using a kind of kneading motion, and sometimes in the first instance drawing it slightly downwards, so as to disentangle it from the neck of the sac. The direction of the pressure is important; it should always be in the line of the descent of the tumor. These means may be employed as soon as the patient is seen by the surgeon, when by steadily carrying on the taxis for a few minutes, he will perhaps hear and feel a gurgling in the tumor, which will be followed by its immediate reduction. If the patient be thin, and the outline of the aperture through which the hernia escapes tolerably defined, the protrusion may be reduced, after failure of the taxis in the ordinary way, by passing the tip of the finger or the nail under the edge of the ring, and pulling this firmly and forcibly on one side, so as to steady and at the same time dilate it, pressure being kept up on the tumor with the other hand. This manœuvre can be practised with more facility and success in femoral hernia, where the upper edge of the saphenous opening is sharply defined, but may also successfully be had recourse to in inguinal and umbilical protrusions. In some cases reduction appears to have been facilitated by placing the patient on his head and shoulders, and raising the body in the vertical position whilst the taxis was being employed. Should, however, reduction not ensue, it will be desirable to have recourse at once to further means, the object of which is, by relaxing the muscles and lessening the bulk of the tumor, to enable the hernia to be reduced.

Auxiliary measures.—The means to be employed must be modified according to the condition of the strangulation, whether it be of the active or of the passive kind. If it be very acute, occurring in a young, robust, and otherwise healthy subject, the patient may have about twelve or sixteen ounces of blood taken away from the arm; he should then be put into a hot bath, where he may remain for twenty minutes or half an hour, or until he feels faint; and, whilst he is in the bath in this condition, the taxis should be employed. If it do not succeed, he should be taken out, wrapped up in blankets, and have chloroform administered. When he is fully under the influence of this agent, which is certainly the most efficient which we possess for relaxing muscular contraction, the taxis may be tried once again. Should it still fail, operation should be immediately proceeded with. No good can possibly come of delay in these cases, and repeated attempts at the taxis should be carefully avoided. If the hernia do not admit of reduction in the early stage of the strangulation, it will necessarily be much less likely to do so when the parts, squeezed and bruised by much manipulation, will have had their congestive condition greatly increased. The frequent employment of the operation without opening the sac, of late years, very properly renders surgeons much less averse to early division of the stricture than was formerly the case.

When the strangulation is less acute, or occurs in a more aged or less robust subject, it is well to omit the bleeding, and to trust to the warm-bath and chloroform.

When the strangulation is of a passive character, and occurs in feeble or elderly people, other measures may be adopted with the view of lessening the bulk of the tumor; which, rather than the tension of the parts, offers the chief obstacle to reduction in these cases. In such circumstances, especially when the tumor is large and not very tense, it is well to dispense with the hot-bath, which has sometimes a tendency to increase any congestion that may already exist in the hernia; I have in more than one case seen a strangulated rupture enlarge considerably after the employment of the bath. In such cases, more time may safely be spent in attempts at reduction than in very acutely strangulated herniæ. It is a useful practice to commence the treatment by the administration of a large enema; which, by emptying the lower bowel, will alter the relations of the abdominal contents, and may materially facilitate the reduction of the tumor. The best enema is one of gruel and castor oil, with some spirits of turpentine added to it; it should be injected through a full-sized tube, passed high up into the gut, and with a moderate degree of force.

strangulated femoral hernia, to whom an enema of about two quarts of tepid water had been administered; and as this had not returned, and did not appear to have gone up the bowel, they suspected that it must have passed out of the rectum into the surrounding areolar tissue. As the patient, however, did not seem to be suffering from this cause, and as the symptoms of strangulation were urgent, I operated on the hernia. Death suddenly occurred, apparently from exhaustion, in about eight hours; and, on examining the body, it was found that the rectum had been perforated, and the fluid injected into the meso-rectum, separating the gut from the sacrum, whence it had extended into the general subperitoneal areolar tissue, which contained a quantity of the liquid; some of the water also appeared to have entered the peritoneal cavity.

In the large herniæ of old people, more particularly the umbilical, in which there is a good deal of flatus, after the enema has been administered, a bladder of ice may be applied for three or four hours with excellent effect. Chloroform may then be given, and the taxis employed under its influence. Of late years, indeed, I have been in most cases in the habit of trusting almost solely to chloroform as a relaxing agent, and have often even dispensed with the use of the warm bath. If, however, this can be conveniently used without too much delay, it should be employed. After this, I put the patient at once under chloroform, and then try the taxis for a period not exceeding half an hour; if this fail, I at once proceed to the operation without any further attempts at reduction, which are not only useless, but injurious by bruising the protruded parts.

Persistence of symptoms after reduction.—After the reduction of the hernia, the symptoms of strangulation may continue unabated. This untoward occurrence may arise from four distinct conditions: 1. The hernia may have been reduced in mass (*vide* p. 973); 2. An internal strangulation has existed within the sac—the taxis having overcome the external stricture, but failing to influence that within the sac; 3. The gut may have been so severely nipped that, although all constriction has been removed, the peristaltic action is not restored, the constricted portion of bowel falling into a state of gangrene; 4. A second hernia may exist in a state of strangulation which has escaped detection.

The diagnosis of these several conditions may possibly be made by attention to the following circumstances. In the *reduction in mass* the tumor has slipped up without any gurgle; the canal is very open, and no trace of sac can be felt in it, but a rounded tumor, possibly at the upper part, on coughing. In the case of *internal adhesions* there will have been no gurgling, but the canal is still filled by the sac; the abdominal apertures are not preternaturally patent and distinct. In the case of *extreme nipping* and consequent paraylsis of a portion of the gut, gurgling will have been felt and heard in effecting the taxis, which does not happen in either of the other conditions, and the symptoms of intestinal obstruction will not be quite complete. The vomiting will lose its stercoraceous character, and probably some flatus will pass. In the case of the *coexistence of a second hernia* in a state of strangulation, the cause of the continuance of the symptoms may be ascertained by careful examination of the abdominal walls. It is especially the coexistence of a small femoral with a large umbilical or inguinal hernia that is apt to be overlooked. This I have seen happen in a very fat person. Hence the folds of the groin should be very carefully examined in all these cases.

The *treatment* of these different conditions is full of difficulty and of anxiety to the surgeon. As a general rule, I think that the proper practice in all cases when the symptoms of strangulation, especially stercoraceous vomiting, continue *unrelieved and undiminished in severity* for some hours after the apparent reduction of the hernia, is to cut down upon the canal, expose the sac, and, if that be found still strictured, as will be found explained at p. 963, divide the constriction. Should the hernia not have been reduced "in mass," it might possibly be found that a small knuckle of intestine is still gripped at the inner and deeper ring; but should that not be the case, it will, I think, be safer not to push any exploration into the abdominal cavity with the view of discovering the possible existence of unrelieved internal strangulation, the presence of which would be highly problematical, and, if existing, could scarcely admit of discovery. The safer and wiser plan under such

Reduction.—The intestine and omentum, having been examined, must be dealt with according to the condition in which they are found; as will be described at pp. 965–968. If these structures be sufficiently healthy to admit of reduction, the intestine should first of all be replaced. This must be done by pushing it back with as much gentleness as possible, and chiefly by using the index-fingers. When it has slipped up into the abdomen, the omentum must be returned in the same way. In reducing the hernial protrusion, after the sac has been laid open, care should be taken that the margins of this are firmly held down by means of a pair of forceps; lest it, together with its contents, be returned *en masse*, the stricture being undivided. After reduction, the surgeon should pass his finger up into the canal through which the hernia has descended, and feel that all is clear. A suture or two should next be applied through the lips of the wound, with a few cross strips of plaster between them, a long pad of lint laid over it, and a spica bandage to retain it all in proper position, and to prevent the protrusion of the hernia again during a fit of coughing, or a muscular effort. I have, however, seen the pressure of the pad occasion so much venous hemorrhage, by producing congestion of the venous tissues in the neighborhood of the wound, as to require it to be laid aside, and the wound to be simply dressed. About the third or fourth day the sutures may be removed, and water-dressing applied. If inflammation or suppuration should set in, the part must be well poulticed; and care should be taken to leave the most dependent aperture free, as otherwise the pus formed in the external incisions may flow back through the internal aperture into the peritoneal cavity, and occasion fatal inflammation. Indeed, I think it desirable that union of the lips of the wound after the operation for hernia should not take place by the first intention; as it not unfrequently happens when this occurs, that the pus and other discharges, not finding a ready outlet, may either be diffused between the muscular planes of the abdominal wall, occasioning sloughing and abscess, or, returning into the peritoneal cavity, may excite inflammation of it—a result which I have more than once seen occur.

After-treatment.—The patient should be kept quiet in bed; and, if there be no sign of peritonitis, should have an opiate given him. The bowels will probably act in the course of the first twenty-four hours; should they not do so, a castor oil and gruel enema may be thrown up. It is, I think, of very great importance not to administer any purgatives in these cases, and to take little heed of the bowels not acting, even for three or four days after the operation. If the mechanical obstacle have been removed, they will be sure to recover their proper action: though, in consequence of the gut having been severely constricted and almost wounded by the pressure of the stricture, it may require to be left quiet for a few days before it can recover its peristaltic action. The administration of purgatives, by still further irritating it, will increase the risk of inflammation in it, and will probably do much harm. The patient, of course, must be kept upon the simplest and most unirritating diet—indeed, he should only be allowed barley-water and ice for the first day or two, and afterwards some beef-tea; but no solid food must be given till the bowels have acted, and all risk of peritonitis has passed.

Accidents and Modifications of the Operation.—The operation having been thus described, we have next to consider in detail certain accidents attending it, or modifications which may be required; such as peritonitis, the management of the intestine according to its conditions, the management of adhesions and of the omentum, wounds of the intestine and of arteries, sloughing of the sac, artificial anus, and fecal fistula.

Peritonitis after operation.—The great danger to be apprehended after operations for hernia is the supervention of *peritonitis*. This may have existed before the operation, may be impending at the time, and may be occasioned, or at all events greatly increased, by the necessary wound of the peritoneum. Two distinct kinds of peritonitis commonly follow operations for hernia; the active or acute, and the passive or latent.

Acute peritonitis is commonly met with in strong and robust people, otherwise healthy, who are the subjects of the operation. It presents the ordinary symptoms of acute idiopathic inflammation of the abdomen; there is tenderness of a diffused character, with lancinating pains. The patient lies on his back, with his knees drawn up, has an anxious countenance, a quick, hard pulse, a dry tongue, and much

inflammatory fever; the respiration is principally thoracic, and tympanitis soon comes on. The bowels are usually constipated, though sometimes irritated. The *treatment* of this form of herniary peritonitis is best conducted upon ordinary antiphlogistic principles; the disease is an active inflammatory one, and proper means must be taken to subdue it. This may be best done by free venesection and the application, perhaps repeated, of two or three dozen leeches to the abdomen; calomel (gr. ij) and opium (gr. ½ or gr. j) in pill must be administered every fourth or sixth hour, and the patient confined to barley-water and ice. When the inflammatory action is subdued, the constipation which is occasioned by it will be relieved without the necessity of administering any purgatives. The tympanitis may best be removed by turpentine enemata, and any lurking tenderness by the application of blisters.

Latent or passive peritonitis appears to be of a diffused or erysipelatous character. It chiefly occurs in old people, or in weakly subjects, and is especially apt to follow upon inflammation of the omentum and its consequent suppuration; or it may occur in consequence of the extension of diseased action from the cutaneous wound, and in other cases from the morbid condition induced by the strangulated gut. In hospital patients especially, in whom all disease is apt to assume a low character, this inflammation is peculiarly liable to occur. In some instances, it sets in without the appearance of any marked local symptoms of inflammation, such as pain or uneasiness in the abdomen; but, two or three days after the operation, the patient becomes depressed, with a quick and weak pulse, an anxious countenance, a tumid and tympanitic abdomen, and rapid sinking of strength. In the majority of cases, however, some of the ordinary local signs of peritonitis are present. After death, the abdominal cavity will be found to contain a quantity of turbid serous fluid mixed with flakes of lymph; in many instances in such quantity as to give it a puriform appearance, and not unfrequently matting together the coils of intestine. In the *treatment*, it is necessary to support the patient, and in some instances even to administer stimulants, such as ammonia, the brandy-and-egg mixture, &c. Depleting measures of all kinds are quite inadmissible; and, indeed, the remedy that offers the most prospect of benefit to the patient is opium, in full doses, one grain being given every third or fourth hour until some effect is produced upon the constitution. Opium not only acts as a useful stimulant in these cases, but has a tendency to allay the increased vascular action. At the same time, a blister to the abdomen, to be dressed with mercurial ointment, may be advantageously employed; and turpentine enemata may be administered, with the view of removing the tympanitis, which is a source of much distress to the patient.

Management of congested intestine.—The condition in which the contents of the sac are found in a case of hernia, determines greatly the course which the surgeon should pursue after the division of the stricture. Most frequently the intestine is deeply congested, being of a reddish-purple, a claret, or chocolate color. This congested state must not be confounded with gangrene of the part, which might happen if the surgeon were to content himself simply with judging of its condition by the color. However dark this may be, the gut cannot be said to be gangrenous so long as it is polished and firm, free from putrescent odor, and without a greenish tinge. In cases in which there is much doubt as to whether its vitality continues or not, it has been proposed to scarify its surface lightly with the point of a lancet. If blood flow from the punctures, this may be taken as a proof of the continuance of the vitality of the part. Such a procedure as this, however, is certainly attended by some degree of danger, and can seldom be required.

When the intestine is merely congested, however deeply this may be, the rule is, that it should be returned into the cavity of the abdomen in the hope of its ultimately recovering itself. This it will generally do if it have not been too much handled after the sac has been opened: but in some cases it will slough a few days after it has been reduced, and, the feces being discharged through the wound, a fecal fistula will be formed; this may happen as late as the eighth or tenth day after the operation.

Management of tightly constricted intestine.—When the intestine has been very tightly nipped by a sharp-edged stricture, so that a deep sulcus or depression is left upon it, it seldom recovers itself, whether the whole of the coil of gut have been thus affected, or the constriction have been limited to a small portion of the diameter of the intestine. It is remarkable how very quickly changes which are incompatible with life may ensue in a portion of gut that has been very tightly strangulated. I

Fig. 487.

Gangrene of intestine from strangulation.

usually dies of peritonitis in the course of a few days, without the bowels having acted, all peristaltic motion having necessarily been annihilated at the injured point. On examination after death, the constricted intestine will be found to present all the appearance of *gangrene*, being of a black or ashy-gray color, without having any flocculi of lymph deposited upon its surface, though these may be in abundance in the neighboring parts. From the very unfavorable result of those cases in which there has been very tight nipping of the protruded bowel, a very cautious prognosis should be given; and, in reducing the gut after the division of the stricture, care should be taken not to push it far back into the abdomen, but to leave it near the inner ring; so that, in the event of its ultimately giving way, there may be less risk of feculent extravasation. In those cases in which the nipping has been very severe, the sulcus being distinctly marked, and the intestine excessively dark and congested, though not actually gangrenous, it would, I think, be better, after dividing the stricture, to leave the gut outside the ring than to return it; the reduction of intestine in this state being almost invariably followed by fatal peritonitis.

It is important to observe that, although intestine, which has been so severely nipped as this, may not be able to recover its vitality, and will fall into a state of gangrene after being reduced, yet it does not, at the time of its exposure, present the characters of putrescence; there is no fetor, no green or pulpy appearance, no loss of polish, no separation of the peritoneum; it is simply of a dark purple or maroon color, and that it has been tightly nipped is evident from the sulcus upon it. There are no signs of gangrene, simply because sufficient time has not elapsed for putrefaction to set in. As, when a pile or nævus has been tied, though vitality be extinct in the part, which is swollen and purple, some time must elapse before signs of putrescence manifest themselves, so it may be with a strictured gut which may have lost its vitality; and it should be treated as mortified intestine, though there be no sign of putridity about it.

Management of gangrenous intestine.—When the intestine is actually gangrenous, the integuments covering the tumor will be infiltrated, brawny, and duskily congested, and the structures immediately overlaying the sac matted together; the sac will contain fetid dark-colored serum or pus; and the softened, lacerable, or pulpy look of the protruded part, its loss of lustre, and peculiar greenish-black or dark-gray color, will cause the nature of the mischief to be readily recognized. In the majority of cases there will be much constitutional depression, a clammy skin, tympanitic abdomen, and brown or black tongue; but in some instances I have known all these symptoms to be absent, and the condition of the patient to present no very unfavorable state. Some difference of opinion exists as to the proper line of practice to be adopted in such cases. Travers and Lawrence seem to think that the division of the stricture is unnecessary, or may even be injurious; whilst Dupuytren, A. Cooper, and Key (with whom I concur), advise that it should be done; that the stricture should be divided in the usual way; that a free incision should then be made into the protruded portion of bowel, which must be left unreduced, so as to allow the escape of feces; and the wound left open, and covered by a poultice. In this way an artificial anus will necessarily be formed, through which the feculent matter finds exit. The gut in the vicinity of the stricture is retained *in situ* by masses of plastic matter, which prevent the peritoneal cavity from being opened. If the intestine should already have given way before the operation is performed, the stricture must be divided, and the part then left unreduced, care being taken to interfere as little as possible with any adhesions or connections lying inside the neck of the sac; though I fully agree with Key, in thinking that the danger of disturbing them has been exaggerated.

When a small portion of the bowel only is gangrenous, the better plan is to return it just beyond the mouth of the sac, without laying it open; but it should not be pushed any distance into the cavity of the abdomen; the pressure of the surrounding parts will prevent extravasation. When the slough separates, it will probably be discharged into the cavity of the intestine; and the aperture resulting will be closed by the adhesions that extend between its margin and the abdominal wall.

Management of adhesions.—This varies according to the condition of the bowel, and the nature and situation of the bands. As has just been remarked, if gangrene be present, especial care must be taken not to disturb any connections that have been formed about the neck of the sac, and which constitute the most effectual barrier against feculent extravasation. When the adhesions are recent, consisting merely of plastic matter, in whatever situation they exist, they may readily be broken down with the finger or the handle of the scalpel, and the parts then returned. When of old standing, and dense, they must be dealt with according to their connections. Most frequently these adhesions occur in the shape of thickened bands, situated within and stretching across the neck of the sac. In other cases, they may be found either as filamentous bands, or as broad attachments connecting the sac with its contents, and perhaps tying these together. When of a narrow and constricted form, and more particularly when seated in the neck of the sac, or stretching like bridles across its interior, they may readily be divided by a probe-pointed bistoury, or the hernia-knife. If they consist of broad attachments, they may be dissected away, by a little careful manipulation, from the parts in the inside of the sac; though, if the adhesions be very extensive and of old standing, it may sometimes be more prudent to dissect away that portion of the sac which is in connection with them, or even to leave them untouched, and the adherent intestine or omentum unreduced, rather than to endeavor to separate them. They may, however, attach themselves in such situations that it becomes necessary to divide them; thus I have, in a case of congenital hernia, found it necessary to dissect away some very extensive and widely spread adhesions that had formed between the omentum and the testicle, and indeed had almost completely enveloped that organ.

Internal adhesions between the omentum and intestine or mesentery occasionally exist, consisting usually of rather firm bands stretching across from one part to the other, sometimes connected with the inner wall of the sac, but in other cases confined to its contents. As these bands may constitute the real stricture, continuing to strangulate the gut after the division of the structures outside and in the neck of the sac, they must necessarily be divided. This operation requires great care, lest the neighboring intestine be wounded. It is best done by passing a director underneath, and cutting the bands through with a probe-pointed bistoury; or if this cannot be done on account of their connections, they must be seized with forceps, and carefully dissected off the gut. In a case of large inguinal hernia, containing both gut and omentum, on which I operated some years ago, I found, after dividing the stricture, and taking hold of the omentum in order to push back the intestine, that this could not be reduced. On searching for the cause of the difficulty, and drawing the mass well down, I found high up in the part corresponding to the neck of the sac, a narrow band, like a piece of whipcord, stretching across from the omentum to the mesentery and firmly tying down the gut. On dissecting this carefully through, the constricted portion of the intestine subjacent to it sprang up to its full diameter, all constriction being removed, and was then very readily reduced.

Management of omentum.—The omentum may require to be treated in one of three ways: 1. It may be returned; 2. It may be left in the sac; 3. It may be cut off. The method of treatment must vary according to the state in which the omentum is found. If it be small in quantity, healthy in character though congested, and apparently recently protruded, not having undergone those changes that occur in it when it has been a long time in a hernial sac, it should be reduced after the intestine has been put back.

If, however, its mass be very large, if it be hypertrophied, indurated, or otherwise altered in structure, or if it be closely adherent to the sac, at the same time that it is congested, surgeons are agreed that it should not be returned into the abdominal cavity; as inflammation of it, *Epiploitis*, will probably set in and terminate fatally with effusion into the peritoneal sac. So also, if the omentum be in large quantity, and have become inflamed in the sac, it should not be returned; as the inflammation in it is very apt to run on to a kind of sloughy condition of the whole mass. If

but, in many of the cases of hypertrophied, and in all cases of inflamed or gangrenous omentum, the best practice consists in cutting off the mass, as recommended by Sir A. Cooper and Lawrence. If it be left in the sac, inflammation or sloughing of it will occur, and the patient can derive no corresponding advantage to the danger he will consequently run. *Excision* of the mass may be done in two ways, either by seizing and cutting it off at a level with the external ring, or by first inclosing the neck of the mass in a small whipcord ligature, and then cutting it off below this. If the first method be employed, the arteries of the stump, which are sometimes rather numerous, are apt to bleed freely: they must be tied singly by fine ligatures, which should be left hanging out of the wound. There is often, however, a tendency to the retraction of the stump of the omentum into the abdominal cavity; in which case the ligatures, dropping into the peritoneum, and acting as setons, may become sources of great irritation: in order to prevent this, the better plan is to knot them together, and to fix their ends by a piece of plaster upon the forepart of the abdomen. The second plan consists in drawing down the mass of omentum, passing a strong double whipcord ligature through its neck, tying this securely on each side, and then cutting off the whole of the mass below the ligature. I have of late years employed it with excellent effect, and indeed, now generally prefer it to the method just described, over which it possesses the advantages of freedom from hemorrhage and impossibility of deep retraction of the cut edge of the omentum into the cavity of the abdomen, provided moderate traction be kept up in the ligatures. The constricted stump of omentum sloughs away in a few days, and separates with the ligature. When this practice is adopted, the wound should not be closed, but must be lightly poulticed. The quantity of omentum that is cut off varies considerably; the mass removed usually weighs from four to six ounces, but in some instances it may amount to a pound or more.

Sacs or apertures are occasionally formed in the omentum, in which a knuckle of intestine may become enveloped, or by the margins of which it may be strangulated. These envelopes of omentum around the gut, which have been especially described by P. Hewett, may occur in all kinds of hernia, at least in the inguinal, the femoral, and the umbilical, and sometimes acquire a large size, completely shutting in the gut. It is of importance to bear the possibility of their existence in mind, and in all cases to unravel the omentum before removing it, lest it contain a knuckle of intestine, which might be wounded in the operation.

Cysts, usually containing pellucid serous fluid, though sometimes filled with blood, are occasionally met with in the omentum. They are globular, elastic, and closely resemble in form a knuckle of intestine, occasioning not a little embarrassment to the surgeon: by a careful examination and unravelling, however, of the omentum, their true nature will be made out; their fluid contents may then be discharged, and the omentum dealt with according to the rules already given.

Wounds of the intestine may accidentally occur at two periods of the operation; either from the surgeon cutting too freely down upon the sac, and opening this before he is aware of what he is about; or else, at the time of the division of the stricture, from a portion of the gut which lies beneath it, getting into the way of the edge of the knife, and being nicked by it. The first kind of accident can only happen from a certain degree of carelessness; but it is not always so easy to avoid wounding the gut, when the stricture is so tight that the finger-nail cannot be slipped under it as a guide to the hernia-knife. In cases of this kind, a very narrow director must be used; and this is a most dangerous instrument, as, in passing it deeply out of sight under the tight stricture, a small portion of the gut may curl up over its side into the groove, and thus become notched by the knife as this is slid along it. This accident has happened to the best and most careful surgeons. Lawrence relates two cases that occurred to him; and Sir A. Cooper, Cloquet, Jobert, and Liston have all met with it. It may be known to have occurred by the bubbling up of a small quantity of flatus and liquid feces from the bottom of the incision. The *treatment* of a wound of the gut must depend upon its size. When it is very small, rather resembling a puncture than a cut, the practice recommended by Sir A. Cooper should be adopted; viz., to seize the margins of the incision with a pair of forceps, and to tie a fine silk thread tightly round them, the ends of which should then be cut off, and the gut returned into the abdominal cavity. Such a proceeding as this does not

appear to give rise to much, if to any, increase of danger. In a case that occurred to me many years ago at the hospital in which, owing to the excessive tightness of the stricture, a very narrow director only could be passed under it, the gut immediately above it was notched and opened by a kind of punctured wound; this was tied up in the way mentioned, and, after the death of the patient, which took place on the fourth day after the operation from gangrene of the strangulated portion of bowel, the silk ligature was found to be completely enveloped in a plug of plastic matter. If the wound be of larger size, it must be closed by the glovers' stitch.

Wound of one of the arteries in the neighborhood of the sac may occur during the division of the stricture, either in consequence of some anomaly in the distribution of the vessel, or from the surgeon dividing the parts in a wrong direction. This accident usually happens to the epigastric or obturator arteries; and Lawrence has collected fourteen recorded cases in which it has occurred. The result in these has been very various; in some the patients have died; in others, after much loss of blood, and consequent faintness, the bleeding ceased spontaneously. The proper *treatment* would certainly consist in cutting down upon and securing the bleeding vessel. In the event of the surgeon operating on a case of hernia, without having been able previously to satisfy himself as to its precise character, or if from any cause, in dividing the stricture, he have reason to dread the proximity of an artery, he may safely and readily divide the constriction with a knife that would not easily cut an artery; and he will find, if he blunt the edge of his hernia-knife by drawing it over the back of the scalpel, that it will still be keen enough to relieve the strangulation, whilst it will push before it any artery that may happen to be in the way.

Sloughing of the sac is of rare occurrence, and, when it happens, is commonly attended by fatal results; it is not, however, necessarily so. It has twice happened in my practice; and in both cases the patient recovered. In an old woman on whom I operated for femoral hernia of very large size, the sac sloughed away, exposing nearly the whole of Scarpa's triangle with almost as much distinctness as if it had been dissected; but, although in much danger for a time from an acute attack of peritonitis, she ultimately recovered.

Artificial anus and fecal fistula.—When an aperture exists in the bowel by which the whole of the intestinal contents escape externally, the condition is denominated an *artificial anus*. When but a small portion so escapes, the greater part finding its way through the natural anus, a *fecal fistula* is said to exist. The quantity of feculent discharge necessarily depends upon the extent of destruction of the intestinal coats; and its character on the part of the gut that is injured. The escape takes place involuntarily, and is usually continuous.

This condition may occur in several ways: Thus, the gut may be accidentally wounded during the operation, and the feces may afterwards continue to be discharged through the aperture so made; or it may have been gangrenous, and have given way into the sac before the operation; or the surgeon may have intentionally laid open a gangrenous portion of intestine, so as to facilitate the escape of the feces. In some cases in which the bowel has been severely nipped, and is dark and congested, though it have not actually fallen into a state of gangrene, it may not be able to recover itself after its return into the abdominal cavity, but will give way in the course of three, four, six, or even ten days after the operation. In these cases, a small quantity of feculent matter is first observed in the dressings; and gradually a greater discharge appears, until at last the fistulous opening is completely established. In such cases, it is of importance to observe that, although the bowel gives way within the peritoneal cavity, the feces do not become extravasated into this, but escape externally. This important circumstance is owing to the fact of the portion of the bowel that is nipped losing its peristaltic action, and consequently remaining where it is put back; the parts in the neighborhood inflaming, throwing out lymph, and becoming consolidated to each other and to the parietal peritoneum, so as to include the gangrenous portion of the gut, and completely to circumscribe it. It is consequently of great importance, in cases of this kind, not in any way to disturb the adhesions that have formed between the sides of the aperture in the gut and the neck of the sac.

The *pathology of artificial anus* is commonly as follows: The edges of the aperture in the gut are glued by plastic matter to the abdominal wall; and, whether the whole or a portion only of the calibre of the intestine be destroyed, the apertures of the upper and lower end, though at first lying almost in a continuous line, soon

they gradually alter in their characters; the lower aperture, being no longer used for the transmission of feces, gradually becomes narrower, until at last it may be almost completely obliterated; whilst the upper portion of intestine becomes dilated in consequence of there being usually some slight obstruction to the outward passage of the feces. The mesenteric portion, opposite the aperture, becomes drawn out into a kind of prolongation or spur, the full importance of which was first pointed out by Dupuytren. This spur-like process projects between the two apertures, and, being deflected by the passage of the feces, has at last a tendency to act as a kind of valve, and thus to occlude the orifice into the lower portion of the gut. The integuments in the neighborhood of such an aperture as this usually become irritated, inflamed, and excoriated, from the constant passage of the feces over them. In some cases, the mucous membrane lining the edges becomes everted, and pouting; and, in others, a true prolapse takes place, large portions of the membrane protruding. An artificial anus fully formed in this way never undergoes spontaneous cure. Besides this, which is the ordinary form of artificial anus, we must, I think, recognize at least two other varieties, both of which I have met in practice. In one of these, the angle formed by the gut is adherent to the upper extremity of the sac which has been returned, and thus lies at some distance from the surface, so that the fecal matter traverses a long canal before it reaches the external aperture. In the other variety the angle of the gut is fixed at a higher point within the abdomen, and the feces find their way out through a channel bounded by agglutinated coils of intestine and layers of lymph. In both of these forms, there is a considerable distance between the external opening and the aperture in the gut. Thus, then, there are three forms of artificial anus, differing from one another according to the situation of the angle of the gut in relation to the external opening and to its connections.

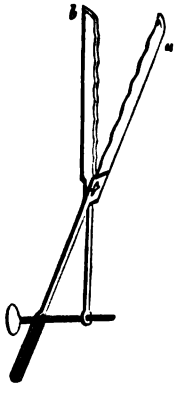
When a *fecal fistula* has formed, the condition of parts is somewhat different. The aperture in the intestine consists of merely a small perforation in its coats, unattended by any considerable loss of substance, through which a quantity of thin fluid and feculent matter exudes, giving rise to a good deal of irritation of neighboring structures. In some cases, there are several apertures communicating with the gut, and extending through the skin. Fistulous openings of this kind not unfrequently undergo spontaneous cure after existing for a few weeks or months.

Treatment.—If the aperture be merely a small one, with a narrow fistula leading into the gut, the chief inconvenience suffered by the patient often arises from the irritation of the skin around the opening by the continued moisture of the feculent matter. In such cases the skin should be protected by means of zinc ointment, spread on lint; and the patient should wear a pad to restrain the discharge. By the pressure of this pad the aperture may sometimes be made to close. In other cases, the occasional application of the galvanic cautery or of a red hot wire will induce contraction of its edges; and in other instances, again, a plastic operation of some kind may be required. But I confess I have not usually seen much advantage result from such operations, which are often followed by erysipelas. As the existence of an artificial anus, by interfering with nutrition, commonly gives rise to considerable emaciation, it becomes necessary to support the patient's strength by a sufficient quantity of good and nourishing food; this is of greater consequence the higher the fistula is, as the interference with the earlier stages of the digestive process, and the loss of nutritive material by the discharge of the chyme, is proportionally great. Spontaneous cure will occasionally take place, even though a perfect artificial anus exist. In a case under my care at the hospital, a whole knuckle of intestine was gangrenous, and sloughed away, leaving an artificial anus, which discharged the greater part of the intestinal contents, but gradually contracted and closed without any local application or treatment beyond attention to cleanliness.

If the aperture become a permanent artificial anus, surgical means must, if possible, be adopted in order to effect a cure. In accomplishing this, two important indications have to be fulfilled: the first is to diminish or destroy the projecting valvular or spur-like process, and thus to re-establish the continuity of the canal; and, after this has been done, the external wound may be closed, by paring its edges, and bringing them together with hare-lip pins.

The first object is best accomplished by Dupuytren's *enterotome* (Fig. 488): this consists of an instrument something like a pair of scissors, with blunt but serrated

Fig. 488.



Dupuytren's enterotome.

Fig. 489.

Enterotome applied.

blades, which may be brought together by acting upon a screw that traverses its handle. One blade of the instrument (*a*) is passed into the upper, the other (*b*) into the lower portion of the intestine; they are then approximated slowly, and fixed by means of the screw in such a way as to compress on each side the spur-like process (Fig. 489). Very gradually, day by day, this screw is tightened so as to induce sloughing of this projection, and cohesion of its serous surfaces. As this action goes on, the irritation caused by the instrument will occasion plastic matter to be thrown out in the angle formed by the intestine, so that the peritoneum and mesentery become consolidated, and all opening into the peritoneal cavity is avoided. Should the spur-like process be accidentally cut through before the lymph is thrown out in sufficient quantity, the peritoneum would be opened, and death would probably ensue; hence the necessity for caution in this procedure. So soon as the blades of the instrument have come into contact, and the spur-like process has consequently sloughed away, the great obstacle to the closure of the artificial anus will be removed; and the continuity of the canal being thus re-established, its lips may be pared and be brought together by hare-lip pins and sutures. [Dr. Physick effected a cure in one instance by cutting the septum, the two intestinal walls having been made previously to unite by means of a tight ligature allowed to remain a week. (Dorsey's *Elements of Surgery*, vol. ii. p. 67.)—A.] In some cases, from the length of time that has elapsed—many years, possibly—the fistula continues permanently patent, and no treatment is available for its erasure. Its existence is not incompatible with good general health. I have at present two cases under my constant observation, in one of which the whole of the intestinal contents have been discharged for four years through an aperture of the umbilicus, in a woman about fifty years of age, consequent on the sloughing away of a large coil of intestine in an umbilical hernia; and another case is a lady of eighty, who has for upwards of thirty years had a fecal fistula in the right groin, consequent on an operation for femoral hernia.

Operation without Opening the Sac.—The possibility of removing the stricture in strangulated hernia without laying the sac open, naturally suggested itself when it was known that in many cases the stricture was seated in the tendinous and cellular tissues outside the neck of the sac, and that, when these were divided, the protrusion was readily reduced. This operation was performed by Petit as long ago as 1718, but was seldom practised until it was revived of late years by Aston Key and Luke. The great advantage sought to be gained by this operation is that, as the peritoneum is not interfered with nor its cavity opened, the risk from peritonitis will be proportionately lessened. The wound made by the operation being altogether superficial, and the sac not opened, its risk has been compared to that of the taxis, with the addition of that which would result from a superficial wound. This argument would be conclusive in favor of the operation without opening the sac, if it could be shown that, in all cases of strangulated

is not the case. In many instances the inflammation exists before any operation is performed, being evidently produced by the stricture of and consequent injury to the gut. But it cannot with fairness be argued that, though the peritonitis may exist before its operation, the incision of the peritoneal cavity does not increase it; even in healthy persons, laying open the abdomen, handling the gut and omentum, and pushing the fingers into the peritoneal sac, would always be followed by intense, often by fatal peritonitis. It is only reasonable to believe that the same procedures in an already inflamed peritoneum would be followed by equally disastrous results.

That the opening made into the cavity of the abdomen in reality adds to the frequency of the peritonitis, cannot, I think, be doubted by any surgeon. It not unfrequently happens in strangulated hernia, that no sign of peritoneal inflammation sets in until one or two days after the operation is performed; and then it occurs evidently as the result of this procedure. That the fatality of the peritonitis, even if existing before any operation be practised, must be greatly increased by interference with the serous sac, is evident from the fact already mentioned, that death very rarely occurs (not more than once in many hundred cases) after the reduction of a strangulated hernia by the taxis. Fully admitting, therefore, that in many cases the peritonitis exists before the operation, and is occasioned by causes independent of it; it is, I think, impossible to deny that the inflammation is frequently directly occasioned by opening the peritoneal cavity, and handling the viscera; and that, when already existing, its fatality must be greatly increased by this procedure. In fact, there are two causes for peritonitis in cases of operated strangulated hernia—viz., the constriction of the stricture, and the wound of the peritoneum. That peritonitis which arises from the pressure of the stricture is equally liable to happen, whether Petit's operation or that by opening the sac be practised, and often precedes the operation; whilst the peritonitis which arises from wound of the serous membrane does not occur in Petit's operation, but is necessarily confined to that in which the sac is opened.

There are, however, two objections that may be urged against Petit's operation with more justice than that it does not tend to prevent the occurrence of peritonitis. The first is that, if the intestine be not seen, it may sometimes be returned in a gangrenous condition; and the second, that the gut may possibly be returned still strangled by bands of adhesion, or by inclusion in an omental aperture. With regard to the first objection, it may be stated that, if the intestine be in a gangrenous state, there will usually be some evidence of this, either in the change that has taken place in the general symptoms of the patient, or in the condition of the sac and its coverings, which will enable the surgeon to guess at the condition of the inclosed parts, and will of course induce him to expose them fully and examine them thoroughly. This objection, however, cannot apply to those cases in which the strangulation has only existed for a time that would be insufficient to allow of the occurrence of gangrene, and does not therefore oppose the performance of Petit's operation in recent cases of strangulation. With regard to the occurrence of internal strangulation, it is excessively rare; and when it does occur, it still more rarely happens, whether the strangulation be effected by bands of adhesion or by an aperture in the omentum, that the parts can be returned without opening the sac, adhesions usually existing between this structure and its contents. But the best answer to the objections against the operation without opening the sac, are the results that have followed this practice. Luke, who has had great experience on this subject, states that he has operated in 84 cases of hernia. In 25 of these the sac was opened; in 59 the sac remained unopened. Of the 25 in which it was opened, 8 died; whilst, of the 59 in which Petit's operation was performed, only 7 died. If to Luke's cases we add those reported by N. Ward, we shall find 36 deaths in 153 cases of Petit's operation. That the ordinary operation, indeed, of opening the sac, is an exceedingly fatal one, is well known to all hospital surgeons, and is fully proved by surgical statistics. Of 77 operations for hernia, reported by Sir A. Cooper, 36 proved fatal; and of 545 cases recorded in the Journals, and collected by Turner, 260 are reported to have died. The result, therefore, of Luke's operations is most favorable, when contrasted with those in which the sac was opened.

The operation without opening the sac may be practised in all forms of hernia,

but is much more readily done in some varieties of the disease than in others. It is especially applicable in cases of femoral hernia, in which the stricture is commonly outside the sac, as will be mentioned when speaking of that form of the disease. Of 81 cases of femoral hernia, operated on by Luke, the sac required to be opened in 7 only. In inguinal hernia it is not so easy to perform Petit's operation; indeed, in the majority of cases the surgeon will fail to remove the stricture in this way. This is owing to the constriction being usually seated in the neck of the sac, and is especially observable in congenital hernia. Of 20 inguinal herniæ operated on by Luke, the sac required to be opened in 13 instances.

For the various reasons that have been mentioned, I am decidedly of opinion that this operation should always be attempted, in preference to the ordinary one of opening the sac, in those cases in which the hernia, not having been long strangulated, presents no sign of the occurrence of gangrene in it, and more especially when it is femoral or umbilical. Even if the surgeon fail in completing Petit's operation, in consequence of the incorporation of the stricture in the neck of the sac, or the constriction of this part, no harm can have resulted; for the sac, after being exposed, may at any time be opened in the ordinary way, and the operation completed by dividing the stricture from within.

When the hernia is of large size and irreducible, it is of especial importance to avoid opening the sac. If it be opened, the contents will inflame, and fatal peritonitis commonly ensues. In these cases, as Luke has pointed out, it rarely happens that the old adherent parts are seriously strangulated, but the whole mischief seems to be occasioned and to be received by the new protrusion that has taken place, and that gives rise to the tension; and if this can be liberated and reduced, the surgeon has done all that need be accomplished. The evidence of the reduction of the recent protrusion, although the old adherent and irreducible hernia be left, is usually sufficiently obvious; the portion of gut returning with a slip and a gurgle, with considerable diminution in the general tension of the tumor.

Operation.—With regard to the mode of performing Petit's operation little need be said here, as it is precisely identical with the steps of the other operation up to the period of the exposure of the sac; except that, when it is not intended to open this, the incisions should be carried more directly over its neck. The stricture, if situated outside the sac, will then be found either in some of the tendinous structures surrounding it, or else in the subserous areolar tissue lying upon it. After the division of the constricting bands in this situation, by means of a probe-pointed knife carried underneath them, or by dissecting down upon them, an attempt at the taxis may be made by compressing the tumor in the usual way, at the same time that its neck is steadied by the fingers of the left hand. If the contents can be reduced, the incision in the superficial structures is brought together by a few strips of plaster, over which a pad and bandage may be applied. Should peritonitis come on, as the result of the strangulation, it must be treated in the usual way. If, after the surgeon has fairly divided all the structures outside the sac, he find still that the return of the hernia is prevented by some constriction in its neck; it will be necessary to lay this open and divide the constriction in the usual way.

Reduction in Mass.—The reduction of the hernia in mass consists in the return of the sac and its contents into the abdomen still in a state of strangulation. When it is said that the parts are returned into the abdomen, it must not be understood that they are pushed back into its cavity, but that the external protrusion is caused to disappear by being pushed into the subserous areolar tissue behind and underneath the parietal peritoneum, between it and the abdominal muscles. This remarkable accident, which was first described by the French surgeons of the last century, received but little notice from practitioners in this country until attention was drawn to it by Luke, by whom its pathology has been carefully studied. Birkett, who has investigated this condition with much care, is of opinion that the sac is not torn from its connections in the scrotum or canal, and pushed back, but that it is ruptured, usually at its posterior part at its neck, and that thus the contents of the sac are forced through this rent into the subperitoneal areolar tissue; whilst the mouth of the sac, still constricting the hernia, and thus keeping it in a state of strangulation, is pushed back from the internal ring. It appears to me that both explanations are correct, and that we must admit two forms of reduction in mass; the sac being pushed back intact in a state of strangulation, in one form, as described by Luke; whilst in the other, as observed by Birkett, the sac is ruptured, and the

Causes.—The reduction in mass has been observed only in inguinal hernia, and has chiefly occurred from the patient's own efforts in reducing a strangulated rupture. It is a remarkable fact that, in most of the instances in which it has occurred, only a very slight degree of force appears to have been employed in the reduction of the tumor; and the accident would seem to have resulted from the adhesions between the sac and the neighboring parts being much weaker than natural, so that a moderate degree of force caused the whole to slip through the canal. It may, however, occur from the surgeon's efforts, if these be too forcible or long continued.

Symptoms.—The symptoms indicative of this accident are constitutional and local. The constitutional symptoms consist in a continuance of those that are indicative of the existence of strangulation, notwithstanding the disappearance of the tumor. The vomiting and constipation persisting, the patient speedily becomes much depressed in strength, being seized with hiccup and prostration of all vital power; signs of gangrene then evince themselves within the sac; and death ensues.

An examination of the parts in hernia will usually enable the surgeon to recognize the nature of the accident; he will ascertain that a tumor had previously existed, and will learn from a description of its general characters, and the symptoms occasioned by it, that it was in all probability a strangulated rupture. He will then find, on examining the part, that there is a total absence of all that fulness which is occasioned by the presence of the sac, even after its contents only have been reduced; the sac, in such cases, always giving rise to a feeling of fulness and roundness in the part. He will, on the contrary, find that the abdominal ring is peculiarly and very distinctly open; it is much larger than usual, and somewhat rounded. On pushing the finger into the canal, this will be felt quite empty; but in some cases, on deep pressure with the finger, especially when the patient stands up or coughs, a rounded tumor may be indistinctly felt behind the ordinary seat of the hernia. In many cases, however, the most careful manual examination will fail to detect any prominence of this kind.

Treatment.—If, after careful examination of such a case as this, in which the symptoms of strangulation continue, the surgeon learn by the previous history that a tumor has existed, but that it has suddenly gone up; and further, if he find that the seat of the supposed hernia presents the negative evidence that has just been described, it will then be necessary for him to push his inquiries a step further by an exploratory incision. Such an incision as this may first be used as a simple means of diagnosis, and, as it does not penetrate the peritoneal cavity, there is no danger attending it; and if the hernia be found, it will serve the purpose of the ordinary incision required in the operation, and may be used for the relief of the strangulation. The first incision should be made so as to expose the abdominal ring; if this be found peculiarly round and open, it would increase the probability of the existence of the condition sought for. The inguinal canal must next be laid open, and the parts contained within it carefully examined. If no appearance of hernial sac be found, but the cord be distinctly and clearly seen, still further presumptive evidence will be afforded of the reduction having been effected in mass; for, if the hernia have been put back in the usual way, the sac will necessarily be left in the canal, and will preserve its usual relations to the cord. This supposition will be strengthened almost to a certainty if it be found that the "condensed cellular capsule immediately investing the sac," as it is termed by Luke—in other words, the condensed and laminated subserous areolar tissue—has been left in the canal. An opening made into this will, as that surgeon observes, allow the finger to be brought into contact with the hernial tumor itself. Should, however, this condensed areolar tissue not be found, it must not be concluded that no hernia is present, inasmuch as this investment may have been accidentally absent. The finger should then be passed into the internal ring, which will probably be found open, and should be carried from side to side; the tumor, if present, will be detected lying externally to the peritoneum behind the abdominal wall. When found, it must be brought down into the canal by enlarging the ring; it must then be opened, its contents examined, and the stricture in its neck divided. The intestine that has been so strangled must be dealt with in accordance with the rules already laid down. If the tumor cannot be readily brought down so as to admit of an examination of it and its contents, the patient should be desired to make some propulsive efforts, so as to cause it to

protrude. If it still do not come down, it must be opened, and the stricture cautiously divided within the abdomen with a sheathed bistoury.

Hydrocele of the Hernial Sac is a rare condition, the pathology of which has already been adverted to. In the *treatment*, two lines of practice are open, the palliative and the curative. The first consists in merely tapping, and thus withdrawing the fluid; and the other in freely laying open the lower portion of the sac, and endeavoring to secure its closure by granulation. This operation, which, however, is not devoid of danger, has been performed with success by Pott and others.

CHAPTER LXIII.

SPECIAL HERNIÆ.

INGUINAL HERNIA.

By *inguinal hernia* is meant that protrusion which occupies the whole or a portion of the inguinal canal, and, when fully formed, passes out of the external abdominal ring into the scrotum. Many varieties of this hernia are recognized by surgeons. Thus it is said to be *complete*, when it passes out of the external ring; *incomplete* or *interstitial*, so long as it is contained within the canal; *oblique*, when it occupies the whole course of the canal; *direct*, when it passes forwards through a limited extent of it; *congenital*, when it lies in the sac of the tunica vaginalis; and *encysted*, or *infantile*, when it lies behind this. Inguinal herniæ constitute the commonest species of rupture, and would be much more frequent than they are, were it not for the obliquity of the canal, and the manner in which its sides are applied to one another, and closely overlap the spermatic cord. They occur with most readiness in those cases in which the canal is short and the apertures wide. Although these herniæ are commonly incomplete in their early stages, it is seldom that they come under the observation of the surgeon until the protrusion has passed beyond the abdominal ring.

Oblique Inguinal Hernia, often called *external*, on account of its relation to the epigastric artery, passes through the whole length of the canal, from one ring to the other; and usually protrudes through the external one, constituting one of the forms of *scrotal hernia*.

Coverings.—As it passes along the canal, it necessarily receives the same investments that the spermatic cord does; although these are often greatly modified by being elongated, hypertrophied, and otherwise altered in appearance. If we regard the inguinal canal as consisting of a series of invaginations of the different layers of the abdominal parietes, the outermost being the skin, and the innermost the fascia transversalis, with the peritoneum applied to this, it is easy to understand how the hernia in its descent has these prolongations drawn over it, thus becoming successively invested with the same coverings as the spermatic cord. Thus it first pushes before it that portion of the peritoneum which lies in a fossa just external to the epigastric vessels; it next receives an investment from the fascia transversalis, which often becomes thickened and laminated, constituting the *fascia propria* of the sac; as it passes under the internal oblique, it receives some of the fibres of this muscle, in the shape of the cremasteric fascia; and, lastly, when it reaches the external abdominal ring, which it greatly distends and renders round and open, it becomes covered by the intercolumnar fascia, receiving also a partial investment around its neck from some of the expanded and thickened fibrous bands that lie near the ring, and which are always most marked upon its outer side.

Relations.—The relations of the spermatic cord and testes, and of the epigastric artery, to an inguinal hernia, are of great importance. The *spermatic cord* will almost invariably be found to be situated behind or rather underneath the oblique inguinal hernia; and the *testis* will be found to lie at its lower and back part, where it may always be distinctly felt. In some cases the elements of the spermatic cord become separated, the vas deferens lying on one side, and the spermatic vessels on

the other. In other rare cases, an instance of which there is in a preparation in the University College Museum, the hernia lies behind the cord, and has the testis in front. In other cases, again, it may happen that the elements of the cord are all separately spread out on the forepart of the hernial tumor. The *epigastric artery* has the same relations to the oblique inguinal hernia that it has to the spermatic cord, lying to the inner side of and behind its neck. The pressure of large and old inguinal herniæ has, however, a tendency to modify somewhat the relations of this vessel. By distending the rings, and dragging the posterior wall of the canal downwards and inwards, they shorten the canal, and cause a great deflexion of the artery from its natural course, which is changed from an oblique direction to one curved downwards and inwards, under the outer edge of the rectus muscle.

Direct Inguinal Hernia.—This does not pass out like the oblique through the internal abdominal ring, but pushes forwards through a triangular space, which is bounded by the epigastric artery on the outer side, the edge of the rectus on the inner, and the crural arch at its base; through this the hernial tumor protrudes, pushing before it or rupturing the posterior wall of the inguinal canal.

Coverings.—These vary according to the length of the canal that the hernia traverses, and the portion of the posterior wall through which it protrudes. In fact, there are at least two distinct forms of direct inguinal hernia, which differ according as they are situated above or below the remains of the umbilical artery. One, the most common variety, is situated below the cord-like remains of this vessel, between it and the outer edge of the rectus. The other, which is of less frequent occurrence, is situated above this vessel, between it and the epigastric artery.

In that form of direct inguinal hernia, which lies *below the umbilical artery*, the protrusion takes place through that part of the posterior wall of the inguinal canal which is situated almost behind and opposite to the external ring. In this situation, the investments successively received by the hernia are, first, the peritoneum and the fascia transversalis; it then comes into contact with the conjoined tendons of the internal oblique and transversalis muscles, which it may either rupture or push before it, thinned out and expanded. Most frequently these are ruptured, constituting a partial investment to the protrusion, which is most evident on the innermost part of the sac, that which is nearest the mesial line. As the hernia passes through the external abdominal ring, it receives from it the intercolumnar fascia and fibres, and lastly is invested by the common fascia and integuments.

In the direct inguinal hernia which lies *above the umbilical artery*, which is of rare occurrence, the protrusion may pass under the lower edge of the transversalis muscle, and then receives a partial investment of cremasteric fascia, especially on its iliac side, as it comes into relation with the internal oblique. This form of direct inguinal hernia, therefore, receives very nearly the same covering that the oblique does, though its investment by the cremaster is not so perfect. It does not come into relation with the conjoined tendons.

Relations.—In the direct inguinal hernia, the *spermatic cord* lies to the outer side of the sac; and its elements are never separated from one another, as occasionally happens in the oblique. The *epigastric artery* also is on the outer side, but usually arches very distinctly over the neck of the sac, sometimes indeed completely encircling the upper as well as the outer margin (Fig. 490).

Incomplete or Interstitial Hernia is usually of the oblique kind; but Lawrence has observed that it may be of the direct variety. It often escapes notice, but may not unfrequently be observed on the opposite side to an ordinary inguinal hernia.

Double Inguinal Herniæ, on opposite sides, are of very common occurrence, and they may be of the same, or assume different forms. In some instances, the two forms may be observed on the same side (Fig. 491).

In females, inguinal herniæ are not very common, except at advanced periods of life; they will then be seen to have the same relations as in the male, except that the round ligament is substituted for the spermatic cord.

Symptoms.—The symptoms of inguinal hernia vary somewhat according to its character, whether interstitial, complete, or scrotal, oblique or direct. In the *interstitial hernia*, a degree of fulness will be perceived in the canal when the patient stands or coughs; and, on pressing the finger on the internal ring, or passing it up into the external ring, and directing the patient to cough, a distinct impulse, together with tumor, may be felt. In the ordinary *oblique inguinal hernia*, a tumor

of an oblong or oval shape, oblique in its direction, taking the course of the canal downwards and forwards, will be felt protruding through the external abdominal

Fig. 490.

Double direct inguinal hernia: neck of sac crossed by epigastric artery.

Fig. 491.

Double inguinal hernia on the same side: oblique above, direct below: separated by epigastric vessels.

ring, and presenting all the usual signs of a hernia. So long as it is confined to the neighborhood of the pubes, it is of moderate size; but when once it enters the scrotum, where it meets with less resistance, it may gradually enlarge until it attains an enormous bulk. The testicle, however, may always be felt tolerably distinctly at its posterior inferior part. In women this form of hernia descends into the labium, but never attains the same magnitude as in men. When of large size, these ruptures usually contain both intestine and omentum, most frequently a portion of the ileum, though the various other viscera, such as the cæcum, bladder, &c., have been found in them. In the *direct inguinal hernia*, the symptoms closely resemble those of the oblique, except that the tumor is more rounded, and usually not so large; the neck is wider, and situated near the root of the penis, with the cord on the outer side.

The different forms of inguinal hernia are not unfrequently complicated with various other affections; either with different kinds of rupture, or with diseases of the cord or testis, such as hydrocele of the cord or of the tunica vaginalis, or varicocele. These various complications necessarily make the diagnosis somewhat more obscure, but with care and practice it may generally easily be made out.

Diagnosis.—The diagnosis of inguinal hernia is usually readily effected, the characters and position of the tumor enabling the surgeon to determine its true nature. In most cases it is useless to endeavor to ascertain whether the hernia is oblique or direct; all old oblique herniæ having a tendency to drag the inner ring downwards and inwards, approximating it and bringing it nearly opposite to the outer one, shortening and destroying the obliquity of the canal. Hence the direction of the neck and of the axis of the tumor in these cases so nearly resembles what is met with in the direct form of hernia, that the surgeon should not attempt to undertake an operation, more particularly the division of the stricture, on any imaginary diagnosis. Some forms of *femoral hernia* may occasionally be confounded with the inguinal; the distinguishing points between these two forms of the disease will be considered in the section on femoral hernia.

The diagnosis of inguinal hernia from other diseases in this vicinity has to be considered under the two conditions in which the rupture is found,—1, *in the canal*, and 2, *in the scrotum*.

1. Whilst still lying *in the canal*, inguinal hernia requires to be diagnosed from the following conditions. *a. Abscess*, descending from the interior of the abdomen or pelvis through the canal, and passing out through the abdominal ring. The diagnosis may here be effected by recognizing the soft fluctuating feel of the abscess,

hernia. *b. Encysted or diffused hydrocele of the cord.* In the *encysted hydrocele* there is a smooth oval swelling situated on the cord, which can be apparently reduced, being pushed up into the canal, and descends again on coughing or straining; but it may be distinguished from hernia by being always of the same size, by not being reducible into the cavity of the abdomen, by the absence of all gurgle, and by its very defined outline. In the *diffused hydrocele* of the cord, the absence of distinct impulse on coughing, the impossibility of returning the swelling completely within the abdominal cavity, and of feeling the cord in a free and natural state, will prevent the disease from being confounded with hernia. *c. Hematocele of the cord.* Here the soft and fluctuating nature of the swelling, the ecchymosis, the impossibility of complete reduction, and the absence of gurgling will indicate its true nature. *d. Fatty or other tumors* occasionally form on the cord; but the circumscribed character and limited size of these swellings, the absence of impulse on coughing, and of reducibility into the cavity of the abdomen, will point out that they are not herniæ. *e. Lodgment of the testis in the inguinal canal* will give rise to a tumor, which closely resembles incomplete inguinal hernia: and if it should happen to become inflamed in this situation, the difficulty of the diagnosis from strangulated hernia may be very considerable. In the ordinary undescended testis, the absence of that organ in the scrotum on the affected side, the peculiar sickening pain occasioned by the pressure of the tumor, the absence of gurgling, and of all possibility of reduction, will enable the diagnosis to be effected. *f. Inflamed undescended testis.* From this it is not always at once easy to effect the diagnosis of incomplete inguinal hernia in a state of strangulation, with which indeed it may be complicated. This diagnostic point will be more fully treated of in speaking of congenital hernia. In the meanwhile it may be stated that the absence of *persistent* and *continuous* vomiting and constipation, the feel of the tumor, hard below, elastic above, and the peculiar pain when it is compressed, will enable the surgeon to recognize the true nature of the tumor as being a retained and inflamed testis.

2. When the hernia has descended *into the scrotum*, it may be confounded with: *a. Hydrocele of the tunica vaginalis.* In this disease there is an oval or pyriform tumor, usually translucent, unchangeable in size or shape by pressure, and having the cord clear and distinct above it, with an absence of impulse on coughing, or of gurgling in attempts at reduction. In cases of congenital hydrocele in children, in which there is still an opening communicating with the peritoneal cavity, the tumor may be diminished in size by steady pressure, but gradually returns again, fluctuates, and is translucent. In these cases its translucency, and the gradual manner in which the sac is emptied and is refilled, so different from the sudden slip up and protrusion of a hernia, enable the surgeon to establish the diagnosis. It not unfrequently happens that *hernia is complicated with hydrocele of the tunica vaginalis.* In these cases the two separate tumors can usually be distinguished, there being some degree of constriction, or of consolidation, between them. The hydrocele will present its ordinary characters of translucency, irreducibility, and circumscribed outline, and is commonly placed anterior to the hernia, which lies towards the back of the scrotum, and may be distinguished by its reducibility and impulse on coughing. It sometimes happens, as in a case which once fell under my observation, that a *hydrocele of the cord is associated with one of the tunica vaginalis and a hernia*; under such circumstances, the diagnosis requires a little care, but may be effected readily enough by separately determining the characters of the different swellings. *b. Varicocele.* Here the diagnosis may be effected in the way pointed out by Sir A. Cooper. The patient should be placed in the recumbent position, and the swelling reduced; the surgeon then presses upon the external ring with his fingers, taking care to cover the whole of it, and desires the patient to stand up. If it be a hernia the tumor cannot descend; but if it be a varicocele, it will speedily reappear *whilst the pressure is being kept up*, the blood being conveyed into it through the spermatic arteries. *c. Tumors of the testis.* These may be distinguished from hernia by their solid feel, rounded shape, by the absence of all impulse on coughing, and, especially, by the cord being felt free and clear above them, and the inguinal canal unoccupied. *d. Hæmatocele of the tunica vaginalis.* Here the cause of the swelling, its pyriform shape, opacity, solid feel, the absence of impulse on coughing, and the defined characters of the cord, will enable the surgeon to make the diagnosis.

Treatment.—When inguinal hernia is reducible, the rupture must be kept up by a well-made truss, the pad of which, of an oval shape, should press not only upon the external ring, but upon the whole length of the canal. It is in this form of hernia that the various operations for the radical cure are most applicable. When it is irreducible, and of large size, nothing can be done beyond supporting it in a bag-truss.

Operation.—When the hernia is strangulated, if the taxis properly employed in the direction of the canal have failed, the operation must be performed in the following way. The bladder having been emptied and the pubes shaved, the patient should be brought to the edge of the bed; and the surgeon, standing between his legs, and having the skin covering the external ring well pinched up, divides the fold in the usual way, by an incision three inches in length, commencing about an inch above the external abdominal ring. Should any spouting vessels, as the superficial external pudic, be divided in this incision, they had better be ligatured. The surgeon then proceeds with the section through the subcutaneous structures; he will, in many cases, find the superficial fascia considerably thickened, particularly if the patient have long worn a truss. He divides this structure in the line of the external incision, and then exposes the intercolumnar fascia, which will also generally be found thickened, and incorporated with the superficial fascia. In many cases, the intercolumnar fibres will be found condensed into a thick and broad fillet, which limits the further extension of the ring, and produces an evident constriction upon the neck of a large inguinal hernia. An opening should be carefully made into this fascia, a grooved director passed under the edge of the ring, and this slit up. In some cases, though but very rarely, it will now be found that the hernia may be reduced, its strangulation depending on the constriction of the margins of this aperture; most commonly, however, the stricture is situated deeper than this. The cremasteric fascia, which is generally considerably thickened, is now exposed, when its fibres will be found to form a kind of reticulated mesh over the hernial tumor. This structure must be carefully divided upon a director, when the subserous areolar tissue, or *fascia propria*, will be laid bare. This structure is usually thickened and vascular, and not unfrequently the stricture appears to be situated in it, or in a kind of condensed ring formed by the incorporation of it with the meshes of the cremaster. If it be found, after the division of these fasciæ, that the stricture has been removed, and the hernia can be reduced, it would of course be unnecessary to lay open the sac; and the safety of the patient will be considerably enhanced, more particularly if the operation be performed for an old scrotal hernia of large size, by not doing so. If, however, as will happen in the majority of instances in inguinal hernia, it be found that the stricture is in the neck of the sac itself, occasioned by a condensation, constriction, and puckering of it, the sac must be carefully opened at its anterior part, the finger introduced, and the stricture divided from within, by pressing the finger-nail under it, and cautiously sliding the hernia-knife along this. It is an established rule in surgery, that this division should be effected in a direction immediately upwards, so that it may lie parallel with the epigastric vessels, whether it be situated upon the inner or outer side of these. It is true that if the surgeon could be sure that he had to do with an oblique inguinal hernia, he might safely divide the stricture outwards; or, if he were certain that the protrusion was of the direct kind, he might make the section inwards; but, as it commonly happens that he cannot determine with absolute certainty upon which hernia he is operating, he adopts the safer plan recommended by Sir A. Cooper and Lawrence, of cutting upwards from the middle of the ring parallel to the epigastric vessels.

The *seat of stricture* in inguinal hernia will thus be seen to differ in different cases; and in some instances it exists in two situations. I think it most commonly occurs in the neck of the sac, owing to contraction and elongation of it, with condensation of the subserous areolar tissue lying immediately upon it. In other cases, though much more rarely, it seems to be formed by a thickening of the transversalis fascia at the inner ring, but altogether outside the sac; occasionally it is met with in some part of the canal, at the lower edge of the internal oblique, but much more frequently at the external abdominal ring. In many cases there is very tight constriction in this situation, as well as in the deeper portions of the canal, or at the inner ring; hence, after the division of any stricture at the external abdominal ring

The operation for an *incomplete inguinal hernia* requires to be conducted in the same way as that which has just been described, except that the incision need not be quite so long, and should not extend beyond the external ring. After this has been laid open, and the tendon of the external oblique slit up, a flat director must be passed under the lower edge of the internal oblique and transversalis muscles, which must be carefully divided; should the stricture not be relieved in this way, and the sac require to be laid open, the deep section must be made in the same way and in the same direction as has already been described.

In *inguinal herniæ, containing either the cæcum, the sigmoid flexure of the colon, or the urinary bladder*, the protruded viscera are only partially covered by peritoneum; hence, in operating upon such herniæ, when strangulated, care must be taken that the contents be not wounded, which is apt to occur if the surgeon divide the parts without due caution, not suspecting himself to have reached the neighborhood of the viscus, but believing that he has met with a sac which does not exist. As the protruded parts are generally adherent in these cases, the surgeon must content himself with leaving them unreduced after the division of the stricture; in such circumstances, it has happened that the protrusion is ultimately drawn back into the abdomen by some natural action of the parts.

Operations for strangulated inguinal hernia are required during a greater range of ages than those for any other kind of protrusion. I have operated successfully for congenital hernia in infants less than six weeks old, and for an ordinary oblique inguinal hernia in one four months of age; and the operation has been done on centenarians. When small and recent, the protrusion usually consists of intestine only; when large, it commonly contains omentum as well. The treatment of these contents, and the after-management of the case, must be conducted in accordance with the rules laid down at pages 965 *et seq.*

Hernia in the Tunica Vaginalis: Congenital Hernia.—In this case the hernia descends inside the tunica vaginalis, which constitutes its sac. It is always oblique, and takes the course of the spermatic cord; most commonly descending into the scrotum, but sometimes lying within the canal, out of which perhaps the testis has imperfectly passed. This hernia differs from an ordinary oblique hernia in the absence of a true peritoneal sac, and in the protruded parts lying in the tunica vaginalis and in contact with the testicle (Fig. 492). The great peculiarity indeed, of this hernia, consists in its descending along the canal left open by the descent of the testis. It is well known that in the fœtus the testis originally lies below the kidney, and, as it descends in the later months of fœtal life into the inguinal canal and scrotum, it pushes before it a prolongation of the peritoneum, exactly resembling a hernial sac.

Fig. 492.

Congenital hernia.

That prolongation of the peritoneum which is carried down around the testis in its descent, may be divided into two portions, the funicular and the testicular. The *funicular* is that which corresponds to the cord, extending from the internal ring to the scrotum; the *testicular* is that which becomes the tunica vaginalis. A congenital hernia occurs in consequence of the funicular prolongation not becoming, as in the normal condition, converted into a filamentous fibro-cellular tissue, but remaining pervious, and thus serving as a medium of communication between the general cavity of the peritoneum and the tunica vaginalis; and along the open channel thus left the congenital hernia descends. The reason why in many cases the hernia is not truly congenital, but occurs in after-life, is that the funicular portion is only partially closed or contracted, and that, under a sudden effort, the septum is broken through, and thus the gut falls into the tunica vaginalis.

Hernia of the tunica vaginalis, though usually called "congenital," is rarely so in reality; the tendency is congenital, but the disease is not. It not unfrequently happens, it is true, that these herniæ show themselves early in life, in infants a few weeks or months old: though at these ages even the funicular prolongation of the peritoneum may be so completely occluded, that the hernia which occurs is of an ordinary oblique character. Not unfrequently, however, the hernia does not take

place until a considerably later period of life than this, and may suddenly happen in the adult; thus, Velpeau relates instances in which it occurred for the first time between the ages of eighteen and twenty-five. I have operated in a case on a man thirty-five years of age, in whom this kind of hernia occurred for the first time when he was twelve years old; and some years ago in a case at the hospital, on a man about fifty, in whom, on the most careful inquiry, it would appear that the protrusion had not shown itself until he was about thirty years of age.

Symptoms.—The symptoms of hernia in the tunica vaginalis closely resemble those of the ordinary oblique; most commonly, however, if scrotal, the tumor is much rounded, and the neck feels narrow and constricted. The testis, also, cannot be felt distinct and separate from the tumor, but is surrounded by, and, as it were, buried in the substance of the hernia, through which it may sometimes be felt at the lower and back part of the scrotum. On inquiry, also, it will usually be found either that the hernia has existed in childhood, or the testis has descended later than usual.

When symptoms of strangulated hernia occur in a person in whom the *testes have not descended* into the scrotum, very great difficulty may be experienced in effecting an exact diagnosis. In such cases as these, an oblong or rounded tumor, tense and painful, will be found to occupy the inguinal canal, not passing beyond the external ring, with some abdominal tenderness, and possibly nausea and constipation. The question here arises as to the nature of this tumor. Is it simply an inflamed undescended testis; or is it an undescended testis, inflamed or not, as the case may be, having a knuckle or loop of strangulated intestine lying behind it?

When the tumor simply consists of an inflamed undescended testis, the pain will be of that peculiar character which is indicative of orchitis, and the constitutional symptoms of strangulation, however simulated for a time, will not be persistently present. The following case is a good illustration of this condition: A man, aged about forty, said to be laboring under strangulated hernia, was sent up from the country for operation. On being called to him, I found the house-surgeon attempting the reduction of the tumor in the hot bath; but as soon as I felt the swelling, I was convinced, from its hard, solid, and irregular feel, that it was not a hernia. On inquiring into the history of the case, it appeared that the patient had for the last two days suffered from occasional vomiting, and had been constipated; that the tumor in the groin had not appeared suddenly, though it had enlarged with great rapidity; that it was excessively painful; and that he had always worn a truss for a supposed rupture on that side, until the last few weeks, when, in consequence of the instrument breaking, he had discontinued it. On examining the groin carefully, a tumor about as large as the fist was found in the right inguinal canal; it was tender to the touch, hard, and irregular at the upper and outer part, but somewhat soft and fluctuating below; when the finger was passed into the external ring, the outline of the tumor could be very distinctly felt in the canal. There was no impulse in it on coughing, but some abdominal tenderness on that side. The right testis was not in the scrotum. I ordered the man to be bled, the tumor to be leeched, and salines administered: under this treatment the case did well. When a knuckle of strangulated intestine lies behind and above the testis, still retained above the external ring, the symptoms of strangulation will be violent and persistent; and this, even though the tumor present but little the feel or the ordinary character of a hernia. In fact, in such a case the surgeon is guided by the character of the general symptoms, and not by those of the local tumor. In a case of this kind to which I was called, there could be felt behind and above an inflamed and swollen testicle, which lay at the external abdominal ring, a small, hard, round tumor in the upper portion of the canal. As symptoms of strangulation were urgent, this was cut down upon, the anterior wall of the canal was incised, and the tunica vaginalis, much distended with fluid, was laid open, when a small knuckle of intestine was found lying at its upper part, very tightly constricted by the inner ring. But in other cases the diagnosis is not so easy; the whole tumor lying in the canal feels smooth, elastic, and uniform, so that no manual examination can enable the surgeon to say with certainty whether the tumor is an inflamed testis surrounded by fluid in a distended tunica vaginalis, or whether there is a loop of intestine lying above an undescended testis. In such cases as these, however, the surgeon is guided in the course he should adopt by the symptoms. If these indicate strangulation of intestine, and persist after a reasonable time has been consumed in the application of

internal ring will require division, the intestine must be reduced, and the testis put back in the canal.

Treatment.—The treatment of congenital hernia consists in the reduction of the tumor, and the application of a proper truss, the pad of which should compress the whole length of the inguinal canal. In some cases in children, a radical cure may be effected in this way; but, in order to accomplish this desirable result, the truss must be worn for at least a couple of years. The application of a truss with an air-pad will in many instances be found especially useful, more particularly in children, in whom it applies itself with greater exactness than an ordinary incompressible one.

When strangulated, congenital hernia does not commonly admit of reduction, and thus necessarily renders an operation imperative. This procedure is more commonly required for this kind of hernia in adults than in infants. The operation is the same as that for oblique inguinal hernia, but the parts concerned are usually thinner, the tunica vaginalis serving for a sac; hence more caution than usual is required in these cases. The sac commonly contains a large quantity of clear or dark-colored fluid; there being, in fact, a hydrocele conjoined with the hernia. The stricture will, I believe, always be found in the neck of the sac, which appears to be condensed, elongated, and narrowed; hence it is useless in these cases to endeavor to relieve the strangulation, without laying open the sac, and dividing its neck from within. As the congenital hernia is always external to the epigastric vessels, the section of the stricture may be done with perfect safety in a direction upwards and outwards; though, if the surgeon should have any doubt as to the exact nature of the case, it will be better to divide the stricture directly upwards. The reduction of the contents of the hernia will often be prevented by adhesions in the neck of the sac, or between them and the testis. I have found both the gut and omentum closely incorporated with this organ, and requiring some nice dissection to separate them. In operating upon infants of a very tender age, much caution will necessarily be required, on account of the tenuity of the coverings, their tension, and the small size of the apertures. The testis, as well as the spermatic cord, the veins of which are excessively turgid, will usually be found much congested, and of a black or bluish-black color.

A species of congenital hernia has been met with in the *female*, especially in children, in which the protrusion takes place into the canal of Nuck, which invests the round ligament. In one instance I have seen a double inguinal hernia in a girl of five years old. It is of extremely rare occurrence, and requires the same treatment as the corresponding disease in the male.

Fig 493.

Infantile hernia.

Encysted Hernia of the Tunica Vaginalis, or Infantile Hernia, as it has been somewhat absurdly termed, occurs in those cases in which the funicular portion of the tunica vaginalis is partly obstructed by a septum, or by being converted into filamentous tissue, but in such a way as to leave a pouch above, which is protruded down behind or into the tunica vaginalis, so that it lies behind this cavity (Fig. 493). There are no characters by which the encysted can be distinguished from the ordinary congenital hernia. If it should become strangulated, it must be borne in mind that during the operation the tunica vaginalis will first be opened; no hernia will be seen here, but the tumor lies behind this sac, and requires to be dissected into through the double serous layer of which it is composed. The stricture will probably be in the neck, and requires to be divided in the usual way.

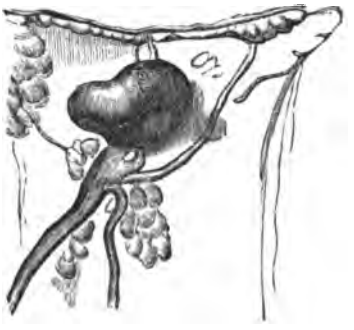
FEMORAL HERNIA.

By *femoral hernia* is usually meant a protrusion that escapes under Poupart's ligament, and enters the sheath of the vessels internally to the femoral vein. This hernia passes down into the innermost compartment of the sheath, which is occupied by fat and lymphatics, and usually contains a gland or two. It passes first of all

through the crural ring, where it has Gimbernat's ligament to its inner side; the septum which separates the femoral vein from the inner compartment of the sheath of the vessels, to its outer aspect; Poupart's ligament in front; and the bone behind (Fig. 494). After passing through the crural ring, it enters the crural canal, which extends for about an inch and a half down the thigh on the pectineus muscle, and is covered by the iliac prolongation of the fascia lata. As it approaches the lower corner of the saphenous opening where the canal terminates, it passes under the falciform pro-

Fig. 494.

Fig. 495.



Femoral hernia turning upwards.

1, Femoral artery; 2, femoral vein; 3, innermost compartment of the sheath of the vessels, into which a small hernia is protruding; 4, saphena vein.

cess of the fascia lata, and out upon the thigh through the saphenous aperture; here it expands, becomes rounded, and has often a tendency to turn upwards over Poupart's ligament (Fig. 495), lying in this way upon the iliac region, and sometimes even ascending to some distance upon the anterior abdominal wall. In the descent of the hernia through this course, it first of all pushes before it the peritoneal sac, and then receives an investment of the subserous areolar tissue. It next comes into relation with the *septum crurale*, a mass of dense areolar tissue, containing fat and lymphatics, occupying the crural ring. This septum often becomes incorporated and matted with the contiguous portion of the sheath, thus constituting the *fascia propria* of this hernia, which is commonly thickened, laminated, and of an opaque fatty structure, like omentum. As the hernia continues to descend, it comes into relation with the cribriform fascia, which occupies the saphenous opening, and, lastly, pushes before it the integumental structures.

As the tumor descends through this course, it necessarily comes into relation with very important parts (Fig. 496). Thus it is separated from the femoral vein solely by the septum of the sheath of the vessels. It has the epigastric artery above and to its outer side; and the spermatic cord in the male, or round ligament in the female, almost immediately above it. The obturator artery, when arising in the normal manner from the internal iliac, does not come into relation with the neck of the sack; but when it takes its origin, as it not unfrequently does, from the external iliac, the common femoral or the epigastric, it may have important relations to this part of the hernia. Most commonly, in these circumstances, it

Fig. 496.

1, Femoral hernia; 2, femoral vein; 3, femoral artery, giving off, 4, common trunk of epigastric and obturator arteries, and 5, epigastric artery; 6, spermatic cord.

passes to the iliac or outer side of the neck, but occasionally it winds round its inner or pubic side, coming into rather close relation with it; and then, as will immediately be mentioned, it may be in considerable danger during the operation. The combination, however, of this particular variety of the obturator artery and femoral hernia, is a very uncommon occurrence; because, in the first place, this internal distribution of the artery is rare; and when it does occur, as it passes directly over that portion of the crural ring through which the sac would protrude, it necessarily strengthens this, and so diminishes the chance of rupture.

Contents.—The contents of a femoral hernia are usually intestinal, and most commonly consist of a portion of the ileum. Occasionally omentum is contained within the sac, but seldom in large quantity. I have, however, several times had occasion to operate in cases of old femoral hernia, in which it became necessary to remove large portions of adherent omentum; in one, ten and a half ounces, and in the other, about seven. In each case there was a small knuckle of intestine strangulated behind the omentum. The ovaries, Fallopian tubes, &c., have been known to be strangulated in this variety of hernia.

Symptoms.—The symptoms of femoral hernia are usually well marked. They consist of a tolerably firm, tense, and unyielding tumor, of a rounded shape, situated in the groin, to the inner side of the femoral vessels, and to the outer side of the spine of the pubes, having its neck under Poupart's ligament, though, as it increases in size, its base may be turned above this structure; sometimes, though rarely, it passes downwards upon the thigh. Its size varies considerably; most commonly it is not larger than a walnut or a pigeon's egg, and then is deeply seated in the angle between the body of the pubes and the femoral vessels; but occasionally it may attain a considerable bulk, as large as the fist or a French roll. When large, this hernia usually rises up above Poupart's ligament, and extends outwards in a direction parallel to it, so that it assumes an elongated shape; it is then usually somewhat doughy and soft, even when strangulated; very different from the excessively tense feel that it has when small.

In some rare cases the femoral hernia has been found lying external to the vessels, the mouth of the sac being between them and the iliac spine. In these circumstances strangulation cannot well occur, inasmuch as the mouth will be the widest part of the sac; but, as Hesselbach has observed, if the fascia iliaca be torn by the pressure of the tumor, the rupture may be strangled in the aperture thus formed. Should an operation ever be required under such circumstances, it must be borne in mind that the circumflex ilii artery may be in some danger.

Diagnosis.—The diagnosis of femoral hernia is not always easy. When the hernia is large, and more particularly when it rises up above Poupart's ligament, which some herniæ, even of very moderate size, are apt to do, it might at first be mistaken for an inguinal rupture. The diagnosis, however, may usually be effected by ascertaining the relation that the neck of the sac has to Poupart's ligament, the inguinal hernia being situated *above*, the femoral *below* this cord. When, however, a small femoral hernia in a fat man rises upwards, so as to overlie Poupart's ligament, it resembles very closely an incomplete inguinal hernia; but its characters may be determined by the passage of the finger up the inguinal canal, which will be found to be free, and the hernia can only be felt through its posterior and inferior wall. In the female the finger cannot be passed up the canal, but the inguinal hernia will descend into the labium, and may thus be recognized from the femoral, which lies in the upper and inner part of the thigh. In both cases the relations of the neck of the sac to the spinous process of the pubes, which can always be felt in the fattest subjects, are most important in a diagnostic point of view. In femoral hernia the spine is to the inner, in inguinal hernia to the outer side of the protrusion; and, should a patient happen to be the subject of both inguinal and femoral herniæ on the same side, the spine would be felt between the two. After reducing the femoral hernia, the finger also can usually be pushed into the inferior aperture of the crural canal, when the situation and sharp outline of the falciform process will determine the nature of the opening through which the protrusion has occurred.

The diseases occurring in the groin, with which femoral hernia may most readily be confounded, are: 1. *Enlarged lymphatic glands* in this situation. From these it may be distinguished by the absence of impulse in the glandular tumor, and by the simultaneous enlargement of several glands. A small strangulated hernia may, however, coexist with these; being subjacent to, and covered in by them. When

this is the case, and the local signs of hernia are obscure, whilst the symptoms of strangulation continue, an incision should be made into the part, and the dissection carefully carried through and underneath the glands, with the view of determining whether the hernia exist or not. 2. *A small fatty growth* has been met with in the crural canal, simulating closely a hernia. The want of impulse on coughing, together with its limited and doughy character, and the absence of circumscription in the tumor, will enable the surgeon to distinguish it from hernia. 3. *Psoas abscess* not unfrequently points very nearly in the situation of femoral hernia: from this it may, however, be distinguished by its fluctuating feel, soft, yet semi-elastic character, and by the general history of the case. The impulse on coughing, which is very distinct in the abscess, is commonly more forcible and direct than that of a hernia; and although the purulent collection may in many cases be squeezed back into the abdomen when the patient lies down, yet it returns without a gurgle, and without that distinct slip which accompanies the reduction of a hernia. 4. *Varix of the saphena vein* is in some danger of being confounded with hernia. It may, however, be distinguished from this by the impulse in it being less distinct, and by the enlargement of the lower part of the vein being marked in the varix, but not existing in the rupture.

Femoral hernia most commonly occurs in women, and very seldom under the age of twenty; differing in both these respects from the inguinal rupture. Sir A. Cooper states that he had only seen three cases under the above age. It very seldom becomes strangulated at an early period of life, even when existing. I have had a girl of nineteen under my care with femoral hernia, in whom strangulation had already occurred on four occasions; reduction, however, having been happily effected each time.

Treatment.—The treatment of femoral hernia, when it is reducible, must be conducted in the ordinary way by the application of a proper truss. A cure, however, is never, I believe, effected by the pressure of a pad, as sometimes happens in inguinal hernia; owing probably to the rigidity and incompressibility of the tendinous and aponeurotic structures through which this rupture protrudes. It is often difficult to keep this form of hernia up by means of a truss. The best instrument for this purpose is the mocmain truss, which I have found to succeed when all others have failed. When the hernia is irreducible, it should be supported by means of a truss with a concave pad.

When a femoral rupture is strangulated, reduction should be effected either by taxis or by operation as speedily as possible, gangrene more rapidly ensuing in this than in any other form of hernia. In attempting the taxis, the structures in the groin should be well relaxed by bending the body forwards and flexing the thigh upon the abdomen; if it do not succeed with the assistance of the means recommended at page 959, the operation should be proceeded with at once. The operation for strangulated femoral hernia may be undertaken earlier and with a better prospect of success than that for any other form of rupture; this is owing to the stricture being so commonly seated outside the sac, that the operation usually admits of being completed without implicating the peritoneum. The advantage of this mode of procedure in femoral hernia has been fully pointed out by A. Key, Luke, and Gay, and is now pretty generally recognized and practised. Gay, more particularly, has pointed out that the stricture may commonly be divided without opening the sac, by making a very limited incision on the inner side of the neck of the tumor; and he justly observes that the operation undertaken in this manner is little more than the taxis with the addition of a superficial incision.

The stricture in femoral hernia is often found to be occasioned by the pressure of the crural arch. Lawrence states that it may be most effectually relieved by dividing the thin posterior border of this arch near the pubes. Other surgeons recommend that the sharp edge of Gimbernat's ligament should be divided; and others again that the division should be made at the junction of Gimbernat's and Poupart's ligaments, through those ligamentous bands which go by the name of Hey's or the ilio-femoral ligament, or at the inner edge of the falciform process; and, indeed, it is in this situation that both Lawrence and Hey direct the incision to be made. In operating for femoral hernia, I have certainly most frequently found the stricture still to continue after the division of these ligamentous structures, and to be occasioned by fibrous bands, often very distinct, narrow, and glistening, lying across the neck of the sac in the fascia propria of the hernia; and I agree with the opinion

expressed by Sir A. Cooper, that the neck of the sheath is the common seat of strangulation in femoral hernia; these transverse fibres, which sometimes appear to be partially reticulated, consisting probably of a condensation of the tendinous fibres that are normally found in the sheath of the vessels. In order to expose them, it is commonly necessary to draw the neck of the sac well down, when they will be seen deeply to indent and constrict it.

The operation without opening the sac may most conveniently be performed, when the tumor is small, by making an incision along the inner side of its neck, and then dissecting through the superficial structures until the fascia propria is exposed and carefully opened, and the sac exposed. The point of the finger should then be carried to the lower side of this, well under the fascia propria. The finger-nail or a flat director may then be insinuated under the sharp edge of Gimbernat's ligament; which, at the point of junction with Poupart's, may be divided upwards and inwards to the extent of a line or two by means of a hernia-knife. By this incision, not only is the edge of Gimbernat's and Poupart's ligament divided, but also the condensed and compressed fascia propria lying between the sac and the inner side of the crural arch. The reduction may now be attempted, and often effected; should any obstacle exist, the neck of the sac must be well drawn down and exposed, and any transverse bands situated upon it dissected through with the scalpel and forceps, or divided on a director. These bands lie in the fascia propria; and when they are found it is usually owing to the surgeon not having closed the neck of the sac sufficiently before passing his nail or director under the stricture. It is owing to the incision being confined to the constrictions occasioned by the crural arch only, not including, as it ought to do, the subjacent condensed fascia propria; a point of very great practical importance. Sometimes this condensed and constricting portion of the fascia propria is so closely incorporated with the neck of the sac, that it cannot be divided without opening the latter. The operation performed in this way, without opening the sac, is certainly a very simple procedure, and adds little to the danger of the patient.

If it be thought desirable to *open the sac*, or if it be necessary to do so in consequence of its incorporation with the fascia propria, the operation must be performed in a different manner, the parts requiring to be rather fully exposed; and, indeed, if the tumor be of any considerable magnitude, even though the sac be not opened, it will be better to expose the part somewhat more freely in the way to be described. An incision should be made parallel to Poupart's ligament, by pinching up the skin, and then a transverse cut from the centre of this carried over the tumor so as to present the following shape ⌉ ⌈ : the dissection must then be carried through the superficial fascia, when the septum crurale or fascia propria will be exposed; in some cases, especially if the hernia be a large one, this is thin, and requires to be carefully slit up on a director. In many instances, however, it is so dense, laminated, and changed in structure, as scarcely to be recognized for what it is. It not unfrequently happens that, after the superficial fascia has been divided, an oval, smooth, and firm body is exposed, which at first looks like the hernial sac, or a lump of omentum; this is in reality the fascia propria, thickened by the long-continued pressure of the truss, and congested perhaps by the attempts at reduction; and in the midst of it, the sac will at last be found, after the dissection has been carried through several layers of this tissue. In it cysts containing bloody serum may occasionally be found, and then the difficulty in the recognition of the structures is greatly increased. Though the mobility of this mass, the facility of tracing its neck, and the roundness of its general outline, often cause it to be mistaken for sac or omentum, it may be distinguished from the first by the absence of the characteristic vessels upon its surface, and from the second by its more rounded, solid feel, and uniform appearance. When the sac has been reached, it must be very carefully opened, there being usually very little if any fluid between it and its contents; the finger-nail must then be passed under the sharp edge of the stricture, which should be divided in a direction upwards and inwards. The reason why this line of incision is universally chosen by surgeons in this country at the present day, is, that it is the only direction in which the stricture can be divided without risk of inflicting serious injury upon neighboring parts. If the section be made outwards, the femoral vein will be in danger; if upwards and outwards, the epigastric artery; if directly

upwards, the spermatic cord: hence the only direction is either inwards, or upwards and inwards. If the cut be made inwards, the sharp edge of Gimbernat's ligament alone will be divided, and the crural arch not sufficiently liberated. But if the division be made upwards and inwards, the ilio-femoral ligament will be divided, and thus the tension of the whole of the arch lessened; the only danger that can occur from the division of the stricture in this direction is the very remote one of the division of the obturator artery, when it takes the anomalous course round the inside of the neck of the sac. Guthrie states that he has known some of the best surgeons in London lose patients by hemorrhage after the operation for femoral hernia. This accident, however, must be of extremely rare occurrence, and might in a great measure be guarded against by slightly blunting the edge of the hernia-knife before dividing the stricture, so that the tense fibrous bands constituting the constriction would yield, while the artery would probably escape, being pushed before the blunted edge. I have, however, more than once seen blood well up rather freely on the division of the stricture; but it has ceased spontaneously, and I have never known it to give any trouble. If the division of the stricture be limited to a line or two, there will be but little danger of wounding the vessel, even when it takes the abnormal course.

It will generally be found that the intestine contained in the sac of a femoral hernia is dark-colored and tightly nipped; it requires to be treated in accordance with the general principles that guide us in the management of hernia.

UMBILICAL HERNIA.

By *umbilical hernia* or *exomphalus* is meant a protrusion through the umbilical aperture. It occurs either in children or in adults.

Umbilical hernia in children is sometimes congenital; and, when so, it has happened that the protrusion has been included in, and accidentally strangulated by, the ligature applied to the umbilical cord. More frequently, however, it occurs shortly after birth, in consequence of the child straining or crying. In these cases it is readily recognized by a smooth, rounded, and tense tumor, starting forwards at the umbilicus, readily reducible on pressure.

The *treatment* should consist in keeping the tumor reduced by the application of an elastic India-rubber belt, with an air-pad that presses firmly upon the aperture; or, should such a contrivance as this not be at hand, the reduction may readily enough be effected by applying over the aperture a piece of soap-plaster spread on amadou, upon which a well-padded slice of cork may be tightly strapped. It most commonly happens that, after pressure has in this way been kept up for some months, a radical cure results.

[A single strip of adhesive plaster, 1½ inches wide by 3 or 4 inches long, will usually be found amply sufficient for maintaining reduction. It should be renewed from time to time, as it becomes loose by washing.—A.]

Umbilical hernia in adults most frequently occurs in women, especially those who have borne many children, or who are loaded with internal fat. It is by no means unlikely that a tendency to this disease is often established in childhood, but does not become developed until the abdominal muscles have been weakened and the umbilical aperture relaxed by the pressure of the gravid uterus.

Umbilical rupture generally attains a considerable bulk, and often acquires an enormous size; when large, it is commonly irregular or semilunar in shape, sometimes appearing to be composed of several distinct tumors. It is usually partly doughy and partly tympanitic to the feel, has a distinct impulse on coughing, and is readily reducible; not unfrequently it happens, however, that a portion of the rupture continues irreducible, owing to the existence of adherent omentum. The coverings of an umbilical rupture are usually extremely thin, consisting merely of the peritoneum, a layer of condensed fascia, which is often perforated at several points by circular openings through which the hernia protrudes, and the integuments containing the umbilical cicatrix, which is expanded over the part. The sac generally contains both intestine and omentum, but the stomach and other viscera have been included in it; and Murray has recorded a case in which the gravid uterus, at the eighth month of pregnancy, formed the contents of an umbilical hernia.

Treatment.—The treatment consists, if the hernia be reducible, in wearing a

properly constructed truss; if irreducible, in applying a hollow cup-shaped pad supported by a bandage over the part. It not unfrequently happens that, in consequence of an indigestible or flatulent meal, an irreducible umbilical rupture in old persons becomes obstructed, the symptoms consisting of tension of the protrusion, with nausea and constipation. In these cases, much discrimination will be required to avoid confounding this passive condition of the tumor with acute strangulation of it. This may be done by attention to the rules laid down (page 957). By leeching, fomentations, calomel and opium, and enemata, relief may usually be afforded. Should, however, the bowels not speedily act, and stercoraceous vomiting come on, the tumor continuing irreducible, it will be better to cut down upon it, and treat it as a strangulated hernia, dividing adhesions, and reducing the swelling; for, if it be left obstructed and unreduced, the whole tumor may run into a state of gangrenous inflammation, and then operative interference will be of little use. In such circumstances death usually results; but I have known the patient to survive the gangrene, the whole of a coil of intestine, the sac, and much mesentery and omentum sloughing away, and an incurable artificial anus resulting.

When an umbilical hernia becomes strangulated, as often happens in old irreducible tumors of this description, the symptoms are not usually very acute at first; but no time should be lost in effecting reduction, if possible, by the taxis, as they speedily assume an active and urgent character. If the taxis fail, the plan that I have usually found to succeed best has been to give the patient three doses of calomel gr. ij, and opium gr. j, every second hour; at the administration of the second dose to apply an ice-bladder; to keep this on for four hours; and then to employ the taxis again, when reduction of some portion of the swelling will rarely fail to occur. Should this not succeed, the operation must be proceeded with without further delay, lest gangrene of the tumor set in.

Operation.—The parts covering an umbilical hernia are usually very thin in places, so that much caution is required in making the early incisions. The stricture should, if possible, be divided without opening the sac. This may usually be accomplished by drawing the tumor well down, and then making an incision in it about two inches in length over the neck at its upper part in the mesial line. If the tumor overlap here, it may be more convenient to make the incision by the side of the umbilical cicatrix, or even between the two lobes of the tumor; but as a general rule, the upper part is the best. After the division of the integumental structures, and often of a deep layer of fat, the end of the nail may be slipped under the edge of the sharp circular margin through which the protrusion has occurred, and, the stricture being divided away from the sac, and if possible in the mesial line, reduction may be readily and safely accomplished. Should the strangulation not be thus relieved, the sac must be opened, and any stricture divided from within. But the surgeon should exhaust every means before he opens the sac of an umbilical hernia, especially of large size, the patient, I believe, rarely recovering when this is done—much less frequently, so far as my experience goes, than in other forms of hernia. Sometimes, after the external division of the stricture, it will be found that there is an internal strangulation in the hernia, the gut having slipped through an aperture formed, I believe, in the condensed fascia covering the sac; if so, the edge of this sharply defined opening may require division. Sir A. Cooper mentions an umbilical hernia forming two tumors, having a communication between them; and South relates a case in which the tumor resembled a figure of 8, a dense areolar band binding down the middle of the sac. In such cases as these, which are by no means uncommon, central constriction may require to be divided as well as the stricture at the neck of the sac. Adherent omentum had, I think, better be left in the sac in cases of umbilical hernia; and gangrenous intestine or omentum must be treated upon general principles. It is not often that strangulation of an umbilical hernia occurs during pregnancy; but, should this happen, the operation must be performed as usual; that condition does not complicate the case much, and instances are recorded by Sir A. Cooper, Lawrence, and others, of its successful performance at this period. After the division of the strictures and the reduction of parts, a large and very thick compress must be laid over the loose folds of integument in the site of the hernia, and be retained in position by a broad and firmly applied flannel roller.

OTHER VARIETIES OF HERNIA.

Ventral Hernia.—By ventral herniæ are meant those protrusions that occur through any part of the abdominal wall, except the inguinal, the femoral, or the umbilical apertures; they most commonly occur in the mid-line between the recti muscles; the linea alba appearing to have given way in this situation during parturition, and here they may attain an immense size. A case was once sent to me from the country, in which there was a long triangular gap through the upper part of the abdominal wall, extending from the umbilicus to the ensiform cartilage, through which a protrusion had taken place that was nearly as large as an adult's head. These ruptures have also been met with in the lineæ semilunares, and in the hypochondriac and iliac regions; and Cloquet describes a case occurring in the lumbar region. When these herniæ happen in the vicinity of the stomach, they are apt to occasion dyspeptic symptoms and much gastric irritation; but Lawrence is doubtless right in thinking that these symptoms do not arise from the implication of the stomach, but simply from irritation of it. These different protrusions have occasionally been met with as the result of injuries, by which the anterior abdominal wall has been lacerated; indeed they seldom, if ever, take place below the umbilicus, unless arising from a directly traumatic cause.

Treatment.—The treatment of ventral hernia must consist in supporting the tumor by means of a broad belt and properly constructed pad. Should it become strangulated, which I believe very rarely happens, owing to the width of the neck of the sac, the operation must be performed in the same way as for umbilical rupture, care being taken to divide cautiously the integuments, any aponeurotic investments, and the peritoneal sac: the stricture should always be divided upwards in the mesial line.

A rare kind of ventral rupture has been described, principally by the German surgeons, in which the abdominal wall has yielded to a considerable extent, forming a broad and expanded tumor, without any distinct neck or pedicle. Sometimes this tumor may attain an immense size, stretching perhaps down to the knees, and containing even the gravid uterus.

Obturator Hernia.—The occurrence of this form of hernia is extremely rare, and its existence has still more rarely been determined until after death; in fact, Lawrence seems to doubt the possibility of the recognition of this complaint during life, in consequence of the small size which the tumor attains, and its being covered in by and compressed under the pectineus muscle. Two instances have, however, been recorded, one by Obré, the other by Bransby Cooper, in which a strangulated hernia of this kind was recognized during life. And these are probably the only instances on record in which an operation has been successfully performed; almost all the other cases mentioned by writers having been accidentally discovered after death, which had occurred from internal strangulation, the precise seat of which could not be detected. In Obré's case, the patient was seized with symptoms of strangulation, but no tumor could be detected in any of the ordinary seats of hernia. "On uncovering the upper part of both thighs at the same time, the eye detected a slight degree of fulness in Scarpa's triangle on the right side; this triangle of the opposite limb was well marked with a hollow, or depression passing down its centre, but this was lost on the affected side, and the whole contour of this part of the limb was visibly fuller than that of the corresponding one. There was no tumor or circumscribed swelling: but, on standing over the patient, and using firm pressure with the ends of the fingers over the neighborhood of the femoral artery, and a little below the saphenous opening, a distinct hardness could be felt (slight in its extent), giving an impression as if the sheath of the vessels were being pressed on." Taking the dangerous state of the patient into consideration, Obré acted in accordance with the best rules of surgery; and, thinking that there might be a hernia deeply strangulated in the femoral canal, he made an incision downwards in this situation, but was disappointed on finding, when the saphenous opening was exposed, that there was no intestine confined there. As, however, a hardened structure could be deeply felt at the inner border of the opening, the fascia lata was exposed, and the pectineus muscle divided to the extent of about two inches, when a hernial sac of about the size of a pigeon's egg, and containing intestine, came into view. In this operation the saphena vein gave some trouble, lying in the course of the incision. The sac

having been laid open, the stricture was divided upwards, during which part of the procedure the vein was accidentally cut, and required ligature; no other vessel was tied. The operation, which reflects the greatest credit on Obré's diagnostic skill and dexterity, was perfectly successful, the patient making an excellent recovery.

Besides the obturator, various other pelvic herniæ may take place, such as a protrusion into the perineum, the vagina, or through the sciatic notch. These various forms of rupture are of extreme rarity, and present many difficulties in their diagnosis.

Perineal Hernia commonly occurs in the middle line, between the rectum and the bladder in men, or the rectum and vagina in women; but sometimes the protrusion has been known to take place by the side of the anus, or even in front of this. Of these various forms of rupture, many instances have been collected by Lawrence from different writers. The *treatment* of such a hernia would consist in supporting the protrusion by means of a pad and bandage; as the mouth of the sac is very large in these cases, it is not probable that any strangulation would occur.

Vaginal Hernia has occasionally been met with; the tumor protruding through the posterior or upper wall of the vagina, and presenting the ordinary characters of this disease, such as impulse on coughing and reducibility. It may most conveniently be kept up by means of a sponge pessary.

Pudendal Hernia has been described by Sir A. Cooper as very closely resembling vaginal rupture. The situation of the tumor may cause it to be mistaken for inguinal hernia; but from this it may be recognized by the upper part of the labium and the ring being completely free, whilst a tumor presenting the ordinary characters of a rupture is situated in the lower part of the labium, and forms a prominence extending along the side of the vagina.

Sciatic Hernia.—This rare form of hernia has been described by Sir A. Cooper as passing through the sciatic notch, where it lies between the lower border of the pyriform muscle and the spine of the ischium. It lies in close relation with the sciatic nerve, and with the internal iliac vessels. In the case related by Cooper, the obturator artery passed above, and the vein below the neck of the sac. From the depth at which such a hernia would be seated, and its small size, it would probably escape observation during life; but, if detected, it might readily be retained by means of proper bandages and a pad. Should operation ever be required in case of strangulation, the deep incisions must be carefully conducted, on account of the great importance of the parts surrounding the sac.

Diaphragmatic Hernia.—This form of hernia is of unfrequent occurrence, and, I believe, always results in consequence of a wound or laceration of the diaphragm. It usually attains a large size, and commonly contains the stomach or the transverse colon, with a portion of the omentum, which form a tumor in the thoracic cavity, encroaching upon the lungs, and pushing the heart to one side. This hernia is not inclosed in a peritoneal sac, but has been found partially enveloped by the pleura, and has, I believe, only been met with in the left side of the chest; the situation of the liver on the right side preventing its formation there. [Dr. A. Müller recently exhibited to the Pathological Society of Philadelphia a specimen of diaphragmatic hernia derived from a patient in the German Hospital, in which the hernia occupied a median position, having entered the anterior mediastinal space.—A.] The following case affords a very good instance of this very rare affection.

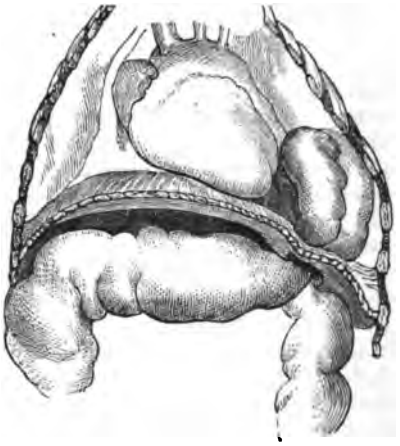
A man, seventy-four years of age, was admitted into University College Hospital. About twelve months before, he fell into an area about ten feet deep; he believed that he injured his chest and head, as from that time he had suffered much from shortness of breath and occasional sensation of suffocation, had a hacking cough, and could not lie down without feeling some difficulty in breathing. At the time of the accident, he coughed up about three spoonfuls of blood. Ever since the accident, he suffered much from dyspeptic symptoms and constipation, though before he met with the injury he had experienced no inconvenience in this respect. About a month before admission, the difficulty in breathing increased; and four days before he came to the hospital, violent pain in the abdomen came on, and his bowels ceased to act, although he took a variety of aperient medicines, and had enemata containing croton oil administered.

On admission, the abdomen was found much distended, tense, and tympanitic, with pain around the umbilicus; the tongue was coated with whitish-brown, moist

fur; the pulse was small, quick, and somewhat resisting; there was nausea, but no vomiting. The skin was cool, and the countenance anxious; the bowels had not acted for seven days, but he had frequent desire to go to stool. He was ordered an aperient draught every third hour. As this had no effect, he was directed to take calomel and elaterium pills, and to have turpentine enemata, which afforded him some relief, though they brought away no feces. The patient became more restless, the skin cold and flabby, the countenance more anxious, the breathing shorter, and the abdomen more tympanitic, and he died two days after admission, and nine from the commencement of the obstruction.

Examination of the body twenty-four hours after death.—The abdomen was distended and tympanitic, and the peritoneal sac contained about six ounces of fluid, with here and there patches of recently effused lymph. The small intestines were not distended; the large were greatly distended with flatus, the cæcum extending into the cavity of the pelvis; the ascending and the transverse colon were much distended, and it was found that a large loop of the transverse and of the descending colon had passed through an opening in the cordiform tendon of the diaphragm into the pleural sac, and was there strangulated (Fig. 497). The colon below the stricture was contracted, and entirely empty. On opening the thorax, the loop of intestine, fourteen inches in length, of a pale slate color, and distended with gas, was found in the left pleural sac. It reached as high as the fifth rib, touched the pericardium, and was overlapped by the free margin of the left lung. Where strangulated, it was of a darker color than elsewhere. The opening in the diaphragm, through which it had passed, admitted little more than the point of the forefinger, and had a thin tendinous margin. The tenth and eleventh ribs, on the left side, were found to have been fractured; the latter was united by osseous matter, but the tenth rib, at the seat of fracture, had formed a false joint. Connected with this and with the intercostal space below it, was a firm adhesion about an inch broad, and an inch and a half long, united by its other extremity in the protruded meso-colon and the diaphragm. The protruded meso-colon was firmly adherent to the upper surface of the diaphragm; close to the opening in it, the lungs were tolerably healthy. The right pleura contained three ounces, and the left eight ounces of serum.

Fig. 497.



Diaphragmatic hernia of colon.

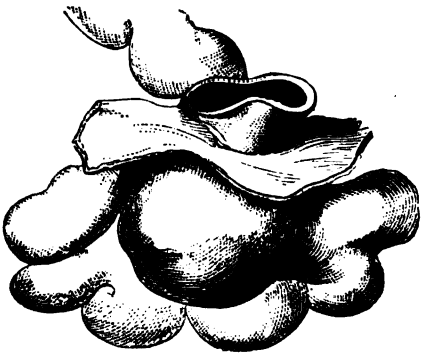
CHAPTER LXIV.

INTESTINAL OBSTRUCTION.

Intestinal obstructions may be of two distinct kinds, the *acute* and the *chronic*, which should not be confounded with one another, as they are usually dependent upon very different conditions, and require different lines of treatment to be adopted for their relief.

Acute Intestinal Obstruction.—This may arise from five different causes. 1. It most commonly occurs in consequence of the formation of an internal hernia, which becomes suddenly strangulated, a portion of gut slipping through an aperture in the mesentery, or omentum (Fig. 498), or becoming constricted by bands, adhesions, or diverticula, stretching across from one side of the abdomen to the other. 2. It may occur from invagination or intussusception, the upper portion of the intestine

Fig. 498.



Intestinal obstruction from internal hernia.

slipping into the lower. 3. It may be produced by a portion of gut becoming twisted upon itself, and thus forming a volvulus, owing to the mesentery or meso-colon being unusually long, and allowing a half twist to take place, in consequence of which complete obstruction occurs. 4. In other instances, as Phillips has pointed out, the same train of symptoms may arise in consequence of a malignant stricture gradually closing, and then at last becoming suddenly occluded. 5. It is of much importance in practice to bear in mind that severe and even fatal intestinal obstruction may occur simply from spasmodic causes, or as the result of inflammatory affections of the abdomen, without the existence of any mechanical lesion.

Symptoms.—The symptoms of acute intestinal obstruction, when arising from a mechanical cause, such as the formation of an internal hernia, or volvulus, are always characterized by very marked vital depression. There is constipation, it is true, from the very first; but this symptom is not the most prominent one, and those that result are evidently, as in an ordinary case of strangulated hernia, the consequence of the injury inflicted upon the intestine, rather than of the mere mechanical obstacle to the onward passage of the feces. At the moment of the occurrence of the attack, the patient is usually seized with a sudden feeling of something wrong having taken place in the abdomen; or he is struck with intense pain at one point. There may be sudden syncope, though most usually the depression of vital power does not amount to this. Vomiting speedily occurs; at first of the contents of the stomach, but after a time of a stercoraceous character; sometimes it assumes this form almost from the very first. The abdomen becomes swollen and tender, the intestines being blown up with flatus, so as to give rise to immense tympanitic distension, rolling over one another, and occasioning loud rumbling and gurgling noises. If the abdominal walls be thin, the rolling of the intestines may be distinctly felt, and in many cases seen, through them: and may sometimes be observed to be continued up to one spot, where it ceases. At this point an intumescence may sometimes be indistinctly felt corresponding to the seat of strangulation. If relief be not afforded, the sufferings of the patient become very considerable, and his mental distress agonizing; the vomiting, perhaps, becomes less frequent, but the depression increases, and at last death results, usually about the sixth to the tenth day, though sometimes sooner, from exhaustion, peritonitis, and gangrene conjoined, the mind being clear to the last, and the patient's attention being intently and distressingly riveted upon the possibility of getting relief from the bowels.

Chronic Intestinal Obstruction.—This usually arises from one of three causes, viz., 1, the gradual obliteration of the inferior portion of the large intestine, in consequence of the malignant degeneration of its walls; 2, the compression of the gut by a tumor growing near it; or, 3, the obstruction of its cavity by the accumulation of large masses of hardened feculent matters.

The *symptoms*, in the earlier stages of these cases, are commonly those that will be described as indicating stricture of the large intestine; but, when once complete obstruction has come on, the constipation becomes the most prominent symptom. In some instances, this will occur without any antecedent leading to the supposition of the existence of stricture. There may be comparatively little constitutional disturbance at first, but the bowels cannot be made to act, and any attempt at forcing their operation by the administration of purgatives, gives rise to sickness and much distress. During the progress of the attack, eructations, retchings, and even vomiting, are of frequent occurrence, but it seldom happens that this is stercoraceous till the very last; there may be much tympanitis, with rumbling and gurgling of the intestines, but most frequently the abdomen fills slowly and gradually, and these symptoms do not occur until after some days have elapsed. The distress of the patient does not depend so much on the length of time that the obstruction has existed, as on the amount of tympanitic distension of the abdomen. The greater this is, the more urgent will be the symptoms. In many instances, life is prolonged for

several weeks, for five or six, even after complete obstruction has set in; and in some cases a recovery may take place even though a very considerable time have elapsed from the occurrence of the obstruction. In a lady whom I attended some time ago, with Mr. Powell, recovery took place, although there had been complete obstruction for upwards of five weeks.

Diagnosis.—I. The diagnosis of the *causes of the obstruction* is of great importance; attention as to whether it assume the acute or the chronic form, will throw some light upon the conditions that occasion it. It is often difficult to determine whether the obstruction is mechanical, or whether it depends upon a spasmodic or inflammatory affection of the intestine. The practice to be adopted in any particular case must at last be determined by a history of the symptoms, by a careful exploration of the abdomen and rectum, and by the light that can thus be thrown upon the question, as to whether the obstruction in the particular case be dependent on causes that are removable or not by medical means. In many instances, the history of the case, the assemblage of strongly marked symptoms, and the result of abdominal and rectal exploration, enable the surgeon to determine, without much difficulty, that the obstruction is dependent on causes that are not removable by any means short of operative interference. But, in other cases, no means that we possess enable us to arrive at a correct or even an approximate diagnosis. Cases are recorded that have ended fatally from obstruction in forty-eight hours, without sickness, fixed pain in the abdomen, or tympanitis. These, however, are certainly exceptional, and do not bear upon the question as to the propriety of performing gastrotomy in those instances in which it can be satisfactorily determined that a mechanical obstacle, not removable by medical means, exists. That the diagnosis may so far be effected with tolerable certainty is evident, from the fact that, in all those cases of gastrotomy which have been of late years practised in this country, by Luke, Hilton, Avery, and myself, mechanical obstruction irremovable by any but operative interference, was found.

The most prominent symptoms, and those that will chiefly engage the surgeon's attention, are—1, the duration of the constipation; 2, the occurrence of fixed local pain in the abdomen; and, 3, the character of the vomited matters.

1. *The duration of the constipation* does not throw much light upon the cause. Indeed, if patients be naturally costive, constipation may last for a considerable number of days, or even weeks, without producing any very serious consequences. Most practitioners must have seen cases in which constipation has continued for three or four weeks, without destroying the patient. Johnson mentions a case, in which it lasted during forty-five days. In these cases, however, constipation has usually come on gradually, being, as it were, an aggravation of the patient's natural condition. In cases of acute internal strangulation, the constipation is always sudden, and is accompanied or speedily followed by other symptoms, indicating intestinal obstruction.

2. *The occurrence of fixed pain* is common to many conditions of the abdomen; though, when taken in conjunction with the sudden supervention of obstruction to the onward passage of the feces, with more or less tumefaction corresponding to the seat of pain, and more especially with the next symptom to which I shall advert, it is not without considerable value in the diagnosis of these cases.

3. *The character of the vomiting.*—Even when the obstruction is not dependent on complete mechanical occlusion of the bowel, there may be incessant vomiting, and the stomach may reject its contents as often as anything is introduced into it; but the vomiting will not be feculent in the majority of cases, however obstinate the constipation may be, and however long it may last. If, however, there be complete mechanical occlusion, feculent vomiting most commonly sets in early, frequently by the third day, or even sooner; and will continue until the cause of occlusion be removed. The vomiting, however, is not continuous, but will usually occur only after food has been taken into the stomach. It is true that feculent vomiting is not sufficient by itself to determine the diagnosis; and that it may occur in cases of pure spasmodic ileus, in which the obstruction is removable by medical means. A remarkable case of this kind occurred at the Westminster Hospital, under Dr. Basham, in the person of a black woman, who was admitted for hæmatemesis, with catamenial suppression. The stomach was very irritable, with occasional colicky pains in the abdomen for the first two weeks. The bowels, although torpid, were not completely occluded till within forty-eight hours of the stercoraceous vomiting This latter condition con-

tinued for five weeks altogether, with an interval in which the bowels acted; indeed, towards the latter period of the case, feculent vomiting occurred on the same day that a small alvine evacuation was obtained. She suffered during a greater part of this period from dysuria. There was also frequent spasmodic constriction of the rectum: and altogether much hysteria was mixed up with the symptoms. The stercoraceous vomiting gradually abated, the natural order of things returned, and she left the hospital sufficiently well to walk to Portsmouth in three days. It is, therefore, as necessary to bear in mind the occasional dependence of feculent vomiting on pure spasmodic ileus, or on other conditions that are removable by medical aid alone, as that it may be absent in cases in which the obstruction, whether seated in the small or in the large intestine, is not under the influence of medical treatment, and can only be relieved by surgical assistance. But I believe that a careful exploration of the abdomen and rectum, and a proper inquiry into the history of the case, will most generally prevent the surgeon from being led into any serious error by trusting too implicitly to the presence or absence of this one symptom.

The following may be given as a summary of the general diagnostic signs: 1. In *internal hernia* the suddenness of the symptoms, the prostration or syncope, fixed pains and vomiting, will throw light on the condition. 2. In *intussusception*, the early age, the fixed pain, with elongated tumor, to be felt on palpation, and possibly through the rectum, with bloody mucous stools and tenesmus, are the chief signs. 3. In *volvulus* the signs of internal strangulation, with very unequal distension of the abdomen, great tympanitis on one side and flattening on the other, are met with. 4. In *chronic stricture* suddenly occluded, the sudden aggravation of the previous long-continued difficulty in defecation will clear up the diagnosis.

II. After determining whether the obstruction be dependent on causes that are removable or not, the next most important point is doubtless to ascertain whether the obstruction is seated *in the large or in the small intestine*. In general, there may be no great difficulty in coming to an accurate opinion on this point, if it be borne in mind that, with the exception of volvulus, obstructions of the large intestines are most generally chronic, whilst those of the small are, in by far the majority of cases if not invariably, acute in their character. The earlier occurrence of feculent vomiting when the obstruction is in the small intestine, the greater tympanitic distension and bulging in the course of the cæcum and colon when it is seated in the large intestine; the amount of urinary secretion being, as was pointed out by Hilton and G. Bird, less in the former than in the latter case; and the result of careful exploration of the rectum will most commonly enable the surgeon to decide this question with sufficient precision to guide him in the choice of an operation. Yet cases do occur in which, though the obstruction be seated in the large intestine, the symptoms are acute, and evidently not dependent on chronic obstructive disease, the vomiting is of early occurrence, the distension of the abdomen slight, and exploration by the rectum yields no result; and it is in cases of this description, presenting a train of symptoms of mixed and uncertain character, that the diagnosis of the precise seat of the obstruction cannot be made.

The question as to whether the cavity of the peritoneum should be opened or not, will altogether turn, in any given case of intestinal obstruction depending on causes that cannot be removed without operative interference, on the point, whether such obstructing cause implicate the bowel above or below the lower end of the descending colon.

1. When the obstruction is situated *below the descending colon*, exploration of the rectum will usually determine to what cause it is more immediately referable. Thus it may be owing to strangulation of internal piles; to compression of the rectum by an over-distended bladder; or to an enlarged uterus, engorged and tilted backwards so as to compress and constrict the rectum, and thus to lead to the supposition of the existence of tumor. If the intestinal obstruction be owing to one or the other of these causes, it may readily be relieved by appropriate treatment. It, however, more commonly proceeds from other conditions in this situation, that do not admit of relief except by operative interference; as from constriction, simple or malignant, of the upper portion of the rectum, or of the lower part of the sigmoid flexure of the colon, in consequence of the pressure of a pelvic tumor, or of a stricture from fibrous or cancerous degeneration of this part of the wall of the gut. In these circumstances, the obstruction may be as complete as in a case of internal strangulation, and the patient will inevitably perish unless relieved by operation. But

there is this important difference between the operative interference that may be called for by these obstructions that are situated below the descending colon, and those at a higher point in the intestinal canal—that in the latter case the peritoneum must be opened; whilst, in the former, relief may be given without interfering with the cavity of the peritoneum, by the operation of opening the descending colon in the left, or the cæcum in the right lumbar region, between the reflexions of the peritoneum at the part where the gut is not covered by that membrane.

2. When the obstruction is situated *above the descending colon*, it almost always occurs in the small intestine, rarely in the cæcum or transverse colon, and may be dependent on various causes, some of which are removable, and others not, and of which preparations may be found in all the large pathological collections in London. Thus, it may be the result of internal strangulation, either occasioned by the small intestine falling into a pouch formed by the meso-colon, or by the constriction of the gut by the passage across it of adventitious bands of fibres. It may be occasioned by intussusception, by the lodgment of biliary or other similar concretions, or by mere spasm of the small intestine, which may be so persistent as to prove fatal. This is, doubtless, a rare occurrence; but cases of the kind are on record, in which the only *post-mortem* appearance that could be discovered has been a spasmodically contracted ileum. The great practical difficulty in all these cases of obstruction, above the sigmoid flexure of the colon, is to determine the cause of the obstruction, whether it be of such a nature as may be removed by operation or not. In some of the cases mentioned, there may be special symptoms, which lead to a tolerably direct diagnosis. Thus, in intussusception, bloody and mucous stools and the existence of an oblong indurated swelling may give a clue; and in children, as the intussusception usually takes place through the ileo-colic valve, the mass of prolapsed intestine may often be felt in the rectum. In malignant or fibrous degeneration of the colon, the chronic nature of the disease, the history of the case, and the appearance of the patient, may indicate the nature of the obstructing cause.

Treatment.—*Treatment of acute obstruction.*—This must necessarily be in a great measure determined by the diagnosis that is made as to its cause. Before proceeding to the employment of any measures, whether medical or surgical, in these cases, the surgeon should never omit to institute a careful examination of the various abdominal and pelvic apertures for some of the more obscure forms of external hernia; for in cases of supposed internal strangulation, it has occasionally turned out, after death, that the patient had been laboring under a small femoral, obturator, or sciatic hernia. If such a condition be detected, it must of course be relieved by proper operative means. In the event of no such protrusion being detected, and from the general obscurity of the symptoms in these cases rendering an exact diagnosis in the earlier stages almost impossible, it is generally expedient to try the effect of proper medical treatment, which will sometimes, even in apparently hopeless cases, afford relief. The only plan of treatment that appears to me of any value is the continued administration of calomel and opium, with the free application of leeches to the abdomen, followed by fomentations; this will be of considerable service, and in some cases, even the most hopeless and complicated, will afford satisfactory results. In a very complicated case of intestinal obstruction which I attended with Dr. Garrod, this plan was eminently successful. A patient was admitted into the hospital under Dr. Garrod, having symptoms of internal strangulation; he had at the same time double inguinal hernia, and a small umbilical rupture, as well as the remains of a fatty tumor, which had been partially removed from the abdominal wall many years previously. There were peritonitis with tympanitis, stercoraceous vomiting, and much depression of power; but, as there was no strangulation existing about any of the external apertures, and as there was no evidence as to the precise locality of the internal mischief, it was not thought advisable to have recourse to operation. The patient was accordingly treated with calomel and opium, together with other antiphlogistic means, when, on the tenth day, the obstruction gave way and the bowels acted, the case ultimately doing well.

Inflation of the obstructed intestine, by the injection of air into the rectum, has been recommended in cases of intussusception, and has occasionally been practised with success. In two instances I have successfully had recourse to it. One was the case of an infant, a few months old, seized with symptoms of intussusception, whom I attended with Mr. Cousins. The other patient was a young lady about ten

years of age, to whom I was called into consultation with Sir T. Watson, Dr. Murphy, and Dr. West; inflation was performed on the fifth day after the setting in of symptoms of acute intestinal obstruction, apparently dependent on intussusception, The proceeding was followed by perfect success: the child felt "as if a bone broke" in the abdomen, the obstruction was removed, and motions followed in three hours, though all the previous treatment had been unavailing. For the convenient performance of this operation, I have had an apparatus constructed, consisting of a circular double-action bellows, with a long vulcanized India-rubber tube, furnished with a stopcock and rectum-tubes of different sizes for children and adults. Should this not be at hand, a well-fitted stomach-pump will answer the purpose. When the air is pumped in, it is doubtful whether it passes beyond the ileo-cæcal valve; but this is of little consequence, in children especially, in whom the inflation of the large intestine alone may be quite sufficient, the obstruction often consisting of the slipping of a portion of the small intestine through the ileo-cæcal aperture.

[In all cases of intestinal obstruction the frequent use of enemata is advisable. Dr. Head has especially recommended the employment of enemata of warm oil. (*St. Bartholomew's Hosp. Reports*, vol. iii. p. 95.) The food administered should be as nourishing as possible, and of small bulk; the use of much liquid should be particularly avoided. Where there is much vomiting nutritious enemata may be employed. Dr. Brinton has forcibly shown the impropriety of giving purgatives, and the advantages to be derived from the free use of opium, or of opium and belladonna combined.—A.]

If, however, for any of the various reasons that have already been mentioned, an internal strangulation of some kind be diagnosed, attended by urgent symptoms, and threatening the life of the patient, the great questions to be determined are, whether it is advisable to have recourse to operative interference; and if so, when it is proper to undertake it? The solution of these questions is fraught with difficulty, and must always be a matter of the most anxious consideration to the surgeon. It is not only that he knows that, if the patient be left unrelieved, he must necessarily die; but that he is aware that the only means of relief, gastrotomy, is probably nearly as fatal as the disease for which it is undertaken; no case in which this operation has hitherto been performed for internal strangulation having recovered. But the difficulties that present themselves in the solution of the question are much increased by the great obscurity in diagnosing the cause of the obstruction, for in many cases it is absolutely impossible to determine with certainty whether it be dependent on ileus, or arise from mechanical causes; and by the fact that apparently desperate cases occasionally recover without operation. If, however, by attention to any of the points that have been pretty fully adverted to, it can be satisfactorily made out that there is an internal strangulation, and more especially if the intumescence occasioned by it can be felt, it will evidently be the duty of the surgeon to give the patient his only chance by the division of the stricture. With regard to the time at which this should be done, the only general rule that can be laid down is probably the conclusion arrived at by Phillips; that operation is justifiable when three or four days have passed without any relief from ordinary means, constipation being complete, and vomiting of fecal matters continuing.

[Gastrotomy is especially to be recommended in cases where herniotomy has been performed, but the seat of obstruction not found, a hernia coexisting with internal obstruction. In a case of this kind Mr. Bryant divided a fibrous band which produced internal strangulation of the bowel, and the patient recovered. (*Med.-Chir. Trans.*, vol. l. p. 65.)—A.]

Gastrotomy may be performed in the following way. The room being well warmed the patient should be laid on a high table, his legs being allowed to hang over the end of it, so as to afford a full view of the abdomen. The bladder having then been emptied, chloroform should be administered; and the surgeon, taking his stand between the legs of the patient, proceeds to make the incision through the abdominal wall. If a tumor can be felt, or the seat of obstruction in any way diagnosed, the cut must be made in a longitudinal manner directly over the seat of mischief; if there be no evidence to show where the obstruction is situated, it had best be made in the mesial line. It must be carried through the abdominal wall until the peritoneum is reached: this must then be slit up by means of a probe-pointed bistoury guided by the fore-finger of the left hand. The coils of intestine will now probably protrude through the wound, curling over its edges; they must be drawn to one side, and be

carefully supported by an assistant, who should press upon them with a soft towel, whilst the surgeon searches for the obstruction. This he does by very carefully and gently tracing upwards the contracted and empty coils, which must necessarily be below the seat of obstruction, or by following downwards the distended intestine. If there be a hernial constriction, he may divide the band that constitutes the stricture by means of the scalpel, or break it through with the finger; or he may withdraw, from the aperture in the omentum or mesentery into which it had slipped, the constricted coil of intestine. If it be a case of volvulus, the gut may be untwisted, as in a case on which I operated. The intestines having been returned, the wound should be closed by the interrupted suture, and the application of some transverse strips of plaster; the patient must then have his knees bent over a pillow, and should be kept principally upon ice and barley-water. Opium must also be administered, and the case generally treated on the ordinary principles of abdominal wound.

Treatment of chronic intestinal obstruction.—This must be conducted upon different principles. Here the great point is to remove the constipation. With this view the rectum should be explored; and, if it be found to be blocked up by rounded masses of impacted feces, as may sometimes happen, these must be broken up and removed by means of an iron spoon or lithotomy scoop, and copious enemata administered. At the same time purgatives may be tried, and a drop or two of croton oil may be given. If the constipation, however, arise from other causes, purgatives will often induce vomiting, and will always considerably increase the patient's distress, and should not be repeated; the patient should be kept quiet in bed, and have a nourishing diet, one leaving little residue is to be preferred—the best consists of beef-tea, eggs, and a small quantity of brandy; and the passage should be opened by enemata, and the introduction of the tube of a stomach-pump. If these means do not succeed, and if the obstruction, as is almost always the case in these chronic instances, be seated in or below the sigmoid flexure of the colon, the intestine must be opened at a point above the seat of disease. This may be required for acute as well as for chronic obstruction; for it may be observed that although, in the acute form, the obstacle is usually situated in the small intestine, yet it is occasionally met with in the colon. But in chronic obstruction it is always the large intestine that is affected. The operation required to give exit to the intestinal contents is of two kinds; in one the intestine is opened in the left iliac fossa, by cutting through the peritoneum covering it. In the other it is opened in the left loin by cutting between the layers of the meso-colon, and thus opening it where it is uncovered by peritoneum.

The first operation, or Littre's, as it has been called, was proposed by a surgeon of that name, in 1710, who advised that in these cases the sigmoid flexure of the colon should be opened from the left iliac region; but it was not until the year 1776 that any operation of the kind was performed, when Pillore, a surgeon of Rouen, was the first to make an artificial anus on the adult, for relief of retention of feces; this he did, not according to Littre's method, but by opening the cæcum from the right iliac region. Fine, of Geneva, in 1797, opened the transverse colon from the umbilical region, in a case of retention of feces produced by scirrhus of the upper part of the rectum.

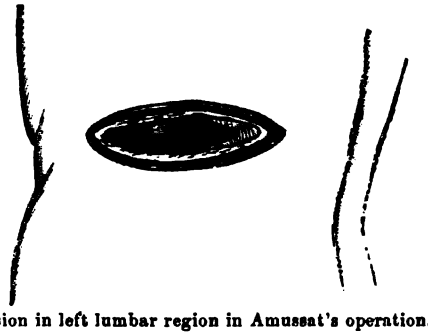
Although these operations serve to fulfil the indication of relieving the retention of the feces, they are all defective in one most important respect; for, as the peritoneum must in all of them of necessity be wounded, an intense and frequently fatal peritonitis is the inevitable consequence. It was to avoid this serious complication that Callisen, in 1796, proposed opening the colon from behind, in the left lumbar region, where it is not covered by peritoneum. He once attempted this operation on the dead body of a child; but, failing in his endeavor to reach the intestine without wounding the serous membrane, he seems to have relinquished all further idea of it; and it was subsequently rejected as impracticable by all writers on surgery who treated of this subject.

Amussat, at the time when he was attending the celebrated Broussais for that scirrhous affection of the rectum of which he ultimately died, was led to reflect on the resources that surgery offers in similar cases; and after making some experiments on the dead body, with the view of contrasting the merit of the different operations that have been proposed for the formation of artificial anus in cases of obstruction of the large intestines, he became convinced that the operation proposed by Callisen, if somewhat modified, was not only practicable, but safe. He soon had

an opportunity of putting this opinion to the test of experiment in 1839, in a private case, at which he kindly invited me, then a student in Paris, to be present; and since this time the operation has been performed at least nearly fifty times.

The following is the way in which Amussat's operation may be performed: A transverse incision is to be made two finger-breadths above and parallel to the crista ilii of the left side, or rather in the middle of that space which is bounded by the false ribs above and by the crista ilii below; the incision should commence at the external margin of the erector spinæ, and extend outwards for about four inches. The spinous processes of the lumbar vertebræ, the crest of the ilium, and the last false rib, are the principal guides. The superior margin of the crista ilii is, however, the safest of these; and the transverse incision may be said to correspond to the middle third of this part of the ilium. After the skin and the more superficial tissues have been divided, the muscular layers of the abdominal wall are next to be incised as they present themselves; if necessary, the external border of the quadratus lumborum may also be cut across. The dissection is then very carefully to be carried through the fine but firm layers of areolo-adipose tissue, which lie immediately upon the intestine. When the patient is fat, these are loaded with adipose matter; when thin, they are semi-transparent and membranous, closely resembling peritoneum, for which, indeed, they may readily be mistaken. These layers immediately overlie the colon, which may usually be felt and seen to bulge through them. After their division, the colon will, in general, readily present itself, and may at once be recognized by its greenish color and distended appearance (Fig. 499). The operation may then be completed by passing a tenaculum, or a needle armed with a strong waxed thread, into the most projecting part of the gut, and by this means drawing it to the surface of the wound, in order to prevent it from shrinking or sinking back when opened. It is now to be punctured with a large trocar or bistoury; and its contents having been evacuated, the sides of the opening in the intestine are to be fixed to those of the incision in the skin by four or five points of suture, so as to prevent the contents of the bowel from being effused into the areolar tissue of the wound (Fig. 500). It is of importance to draw the colon well

Fig. 499.



Incision in left lumbar region in Amussat's operation.

Fig. 500.

Colon opened and stitched to sides of incision.

forwards before opening it, in order to prevent its contents from being effused into the loose areolar tissue of the wound, where they may set up considerable irritation and retard the union of the parts. If the patient be very fat, the operation is proportionately difficult on account of the depth of cellulo-adipose tissue lying in front of the quadratus, which requires to be very carefully dissected through before the gut can be reached. This step of the operation will be much facilitated by dividing the deeper seated tissues in a crucial manner, so as to give the operator more space.

When the operation is practised on the dead body, it will be found on dissection that the following are the parts cut through. After the skin and areolar tissue, the latissimus dorsi will be seen divided towards the posterior third of the incision, and the obliquus externus in the anterior two-thirds of it; the obliquus internus and the transversalis, sometimes the quadratus lumborum, the cellulo-adipose tissue which immediately covers the intestine, and finally the colon itself, come into view. The colon will usually be found a little in front of a point that lies midway between the anterior and the posterior spines of the ilium. After the more superficial incisions have been made, the surest guide will be the line of condensed fascia which

forms the anterior edge of the sheath of the quadratus, and which lies between that muscle and the transversalis. This line may always readily be distinguished by its buff color from the surrounding muscular structure. Very few vessels or nerves are wounded, as they for the most part run parallel to the line of incision; whereas, if the vertical incision of Callisen were adopted, they would necessarily be cut across.

Amussat's operation may also be required in cases of cancer of the rectum, when there is perhaps but little or no distension of the gut; the object being to prevent the feces from passing over and irritating the ulcerated surface. In such cases, the operation is somewhat difficult of execution; for, on account of the contracted state of the colon, that intestine recedes behind the quadratus lumborum, and the folds of peritoneum nearly surround or invest it; and it is so covered in by fat and areolar tissue, that a very cautious dissection is required to expose it without wounding the peritoneum. The difficulty may to a certain extent be lessened by throwing up a large bland enema just before the operation, so as to distend the gut somewhat forcibly.

Lastly, it may be required in cases of imperforate children in whom the rectum is absent, so that the gut cannot be reached through the perineum. In operating on the newly-born infant, it must be borne in mind that the kidney is very large, extends far outwards, and is enveloped in very little if any fat, and that the mesocolon is often so long that there may be a difficulty in opening the gut without wounding the peritoneum. I am disposed to think that in these cases it may be better to open the cæcum in the right flank than the descending colon in the left.

When we compare the different operations that have been proposed for the formation of an artificial anus, it will be found that Callisen's, as modified by Amussat, is the one to which the preference must be given; for by it alone the peritoneum is not wounded, and thus the inflammation of that membrane, which is a necessary and so often a fatal consequence of the other operations, is avoided. Beside this advantage, which is of the very greatest importance, Amussat's operation presents several other claims to our notice. As only one side of the colon can be drawn forwards, and not a knuckle of it, as would be the case if the small intestines were operated upon, it is evident that the spur-like process, which has been described by Dupuytren, must exist to a very small extent; and consequently, if the artificial anus should ever become useless, the natural passage for the feces having been re-established, it could readily be closed up. If, however, the peritoneum should be accidentally wounded in the attempt to reach the colon from behind, even then this operation would be preferable to that of Littre; for, the cavity of the abdomen having been opened at its most depending part (in the recumbent position), the fecal matter would have much less tendency to be effused into it, than if it were opened in front. In respect of not wounding the peritoneum, this operation closely resembles that of puncturing the bladder above the pubes, and below the reflection of that membrane. There is, however, one important difference between the two operations, which may influence the result; in the one case, as the patient lies upon his back, the urine has a tendency to stagnate in the wound, being obliged, in order to escape, to mount against its own gravity; whilst, in the other case the fecal matters find a ready exit from a wound situated in a depending part.

Cæsar Hawkins, in a paper published in the 25th volume of the *Medico-Chirurgical Transactions*, has collected and analyzed 44 cases, in which an artificial anus has been formed by opening the intestine; in 17 of these the artificial anus was made through the peritoneum, and in 27 behind that membrane; but for various reasons, which are stated at length in the paper, Hawkins excludes 5 of the cases of peritoneal section, leaving only 12 to compare with 26 cases of operation behind this membrane. Of the former, he finds that 7 died and 5 recovered; the recoveries amounting, therefore to only forty-one per cent. in the cases of this category; whilst of the 26 cases where the peritoneum was uninjured, 10 died and 16 recovered; the proportion of recoveries in the cases of this category amounting to sixty-one per cent. Though the large intestine was opened in all these cases, the operation was performed on the *right* side in 10 instances; in 4 cases the right colon and cæcum were opened through the peritoneum, and of these all died; whilst of the remaining 6, in which the right colon was opened behind the peritoneum, 4 recovered. The preference, therefore, as Hawkins observes, on the right side, is certainly due to the lumbar operation. It is remarkable, however, that in the operation on the *left* colon, the results are somewhat different; for, of 8 cases in which this intestine

was opened through the peritoneum, 5 recovered and 3 died; whilst of 20 cases in which the lumbar operation was performed, 11 recovered and 9 died. Hawkins observes, that the inequalities of the numbers appear, however, to leave the question as to the mode of operating on the descending colon still undecided; and that an operator is justified in selecting whichever situation he thinks best for the formation of an artificial anus on the left side of the body; still, for the reasons that have already been given, I should very decidedly prefer Amussat's to Littre's operation. In those cases in which death has resulted from Amussat's operation, peritonitis does not appear to have exercised any material influence; and the fatal result seems rather to have depended on the influence of previous disease on the constitution of the patient, or on changes taking place in the diseased bowel, than on the operation itself, which appears occasionally to have been uselessly done at the last extremity. We should, therefore, have less hesitation in performing the extra-peritoneal operation in an early stage of those cases in which it is called for, than we should if the section itself were attended with any serious risk to the patient's life.

CHAPTER LXV.

TAPPING THE ABDOMEN.—TUMORS OF THE GROIN.

TAPPING THE ABDOMEN.

THE abdomen often requires *tapping*, either for ascites or for encysted dropsy. This operation, which is perhaps the simplest in surgery, may be performed as follows. The bladder having been emptied, the patient is seated on the edge of the bed or of a large chair, or if very weak lies on the side, and has a broad flannel roller, split at each end to within six inches of the middle, passed around the body in such a way that the untorn part covers the front of the abdomen, whilst the ends, which are crossed behind, are given to an assistant on each side, who must draw tightly upon them as the water flows. The surgeon then, seating himself before the patient, makes a small incision with a scalpel into the mesial line about two inches below the umbilicus, and through the opening thus made, he thrusts the trocar; as the fluid escapes, the patient often becomes faint, but this may commonly be guarded against by continuing to draw upon the bandage so as to keep up good pressure in the abdomen. After all the fluid has escaped, the aperture must be closed with a strip or two of plaster supported by a pad and bandage.

The incision through which the trocar is thrust need not enter the peritoneum, though if it do it matters little. The trocar itself must be of full size with a well-fitting canula. Sometimes it is convenient to have one fitted with a stopcock, to the end of which a vulcanized India-rubber tube may be adapted, by which the fluid is carried quietly and without splashing into the pail destined to receive it. Should the particular character of the accumulation of fluid in encysted dropsy not admit of its withdrawal by an aperture below the umbilicus, the abdomen may be tapped in any other convenient situation, except in the course of the epigastric vessels.

TUMORS OF THE GROIN.

Tumors of various kinds may develop primarily in the groin, or descend into it from the abdomen. They are of the following kinds: 1. Enlargement of the lymphatic glands. 2. Abscess in or around those glands. 3. Abscess descending into the groin from the abdomen—psoas, iliac, pericæcal, perinephritic, &c. 4. Varix of the saphena vein at its entrance into the femoral. 5. Aneurisms of all kinds. 6. Osteo-aneurisms. 7. Cystic tumors, bursal, and developing in the muscular structures. 8. Simple solid tumors, as fatty, fibro-cellular, fibro-plastic, and fibroid. 9. Malignant tumors, primarily developing in the soft structures in this region, extending into it from the bones, or secondarily from contamination of the glands. 10. Herniæ of different kinds—inguinal, femoral, and obturator.

Diagnosis.—In effecting the diagnosis of these various tumors, we must first distinguish the pulsating from those that do not pulsate. The *pulsating* must either be aneurisms, osteo-aneurisms, or cancers or abscesses with communicated pulsation. The diagnosis of these different forms of disease has already been so fully given at pages 596 and 705, that I need not enter upon it here.

The *non-pulsating tumors* are to be divided into two great classes, viz., the *reducible* and the *irreducible.*

The *reducible tumors* of the groin are either hernia, varix of the saphena vein, or abdominal abscess presenting under Poupart's ligament. The diagnosis of these different conditions is given at p. 984. These have all an impulse communicated to them in coughing.

The *irreducible tumors* of the groin have further to be divided into those that contain *fluid* and those that are *solid.*

The irreducible tumors *containing fluid* are either abscess in or around the lymphatic glands, or cystic growths of various kinds. The diagnosis here is easy: the irregular hardened outline of glandular abscess, its rapid development, and softening from a previously indurated state, will distinguish it from the tense, clearly defined outline, smooth and elastic feel of the slowly developing and very chronic cystic growth. In irreducible hernia the impulse on coughing, the gurgling, and other peculiar signs characteristic of that disease, will prevent the possibility of error in diagnosis.

The *solid* tumors in the groin may either be simple or malignant. The history of the case, the feel of the tumor, the rapidity of its progress, the extent of contamination of neighboring parts, and the other signs that serve as diagnostic differences between simple and malignant growths, will enable the surgeon to effect the diagnosis with sufficient accuracy.

The **Treatment** of many of these tumors, such as abscess of various kinds, aneurism, varix, and hernia, has already been so fully considered in the various chapters devoted to these diseases, that I need not enter upon it here. But the question of operating for the *removal of cystic or solid tumors* of the groin, is one that presents several special points for consideration. These are, the relations of the morbid mass, 1st, to the femoral vein; 2d, to the femoral artery; and 3d, to the abdominal cavity. If the tumor lie upon or compress the femoral vein, œdema of the foot and leg will be the result; and, should the compression have been prolonged and very chronic, this œdema may assume a semi-solid character, so as to occasion a condition of the limb closely resembling elephantiasis. Although an intimate relation such as this between the tumor and vein would obviously inculcate the necessity for extreme caution, it need not necessarily preclude the idea of operating for the removal of the tumor, which may possibly be altogether above and unattached to the sheath of the vessels. I once successfully removed a tumor of many years' standing of a nævoid and lipomatous character, in which the limb was in a state of spurious elephantiasis from compression of the femoral vein, but in which the vessel was not involved in the growth. If the femoral artery be compressed to such an extent as to interfere with the circulation through the lower part of the limb, it will most probably be found that the tumor dips under or surrounds the vessel, so as to render removal impracticable. The mere overlying of the artery by a freely movable mass, without any compression of the vessel, need not preclude operation. The growth figured p. 788 was of this kind. The connection of the tumor with the abdominal or pelvic cavities under Poupart's ligament, or through the obturator foramen, must be most carefully examined. Should this exist, or even be strongly suspected, operation is necessarily quite inadmissible.

CHAPTER LXVI.

DISEASES OF THE LARGE INTESTINE AND ANUS.

CONGENITAL MALFORMATIONS.

Congenital malformations of the anus and rectum are by no means of unfrequent occurrence, and are of considerable importance; for, if unrelieved, they must necessarily be the cause of speedily fatal intestinal obstruction. They may exist in various degrees, which may most conveniently be arranged under the following heads.

Narrowing and Partial Closure of the Anus.—The canal continues pervious, but not sufficiently so to allow of the bowels being completely emptied, the contraction usually merely admitting a full-sized probe; in some cases the obstruction appears to depend upon constriction of the anal orifice, in others upon an imperfect septum stretching across it.

Treatment.—This consists in notching the contracted anus with a probe-pointed bistoury, and then introducing a sponge-tent, so as to dilate it to the proper size, to which it must be kept by the occasional introduction of a bougie.

Complete Closure of Anus.—The anus may be completely closed by a membranous septum stretching across it, usually having a raphe along the central line, and a slight depression, through which the dark meconium can be seen, and on which an impulse can be felt. This constitutes perhaps the most common form of malformation that is met with.

Treatment.—In this variety an incision must be made through the septum along the middle line, and this again cut across on each side, when the meconium will freely escape. The four angular flaps that are left must now be removed, and the aperture kept open by the introduction of a well-oiled plug.

Occlusion of Rectum above the Anus by a Membranous Septum.—The anus may remain open; but, at a distance of about half an inch or an inch from its aperture, the rectum will be found occluded by a perfect membranous septum stretching across it. This is a rare and somewhat puzzling kind of malformation, as in it the infant will be found to labor under intestinal obstruction, and yet, on examination, the anal orifice will be found perfectly formed, and thus the surgeon may be misled as to the seat of the obstacle. He will, however, detect it by introducing a probe or the end of his little finger into the anus. In several cases of the kind which have been brought to me, I have opened the septum by puncturing it with a large trocar, and, after the lapse of a few days, dilated the aperture by means of a sheathed bistoury, the cases ultimately doing well. It is important to observe that, although the anus may be perfectly formed and patent, with a canal above it about half an inch long, the rectum may be entirely absent, the sigmoid flexure terminating in an immense cloaca opposite the sacral prominence. In such cases it is of course impossible to reach the gut through the anus. In a case of this kind, in an infant four days old, in which I was unable to reach the gut through the anal aperture, I performed lumbar colotomy.

Complete Absence of Anus.—The anus may be completely absent, being blocked up by a dense mass of fibro-cellular structure, from half-an-inch to an inch in thickness, above which the rectum terminates in a kind of *cul-de-sac*.

Treatment.—An incision about an inch in length should be carefully made, from the point of the coccyx forwards, and the dissection carried down until the gut is reached; this must then be punctured, and the meconium allowed to escape. If the cut surface be left to granulate, with a plug of lint merely interposed between its sides, it will gradually contract, and degenerate into a fistulous opening, through which the meconium will escape with difficulty; and, as this track is not lined by a mucous membrane, the probability is that the irritation set up along it by the intestinal matters will ultimately prove fatal to the child. Indeed, it commonly

happens in these cases that death results in a few days, from irritation occasioned by the absorption of the excreted fluids. In order to obviate this source of danger, Amussat thought of bringing down the mucous membrane of the bowel to the anal orifice, and fixing it there by sutures, so as to afford the meconium a mucous canal to pass through, and thus to prevent the diffuse inflammation which is apt to take place in the areolar tissue of the pelvis, by the contact and absorption of the effused matters. In many cases it is by no means easy to do this, but it should always be attempted, as I believe the whole safety of the child depends upon this being carried out. For some considerable time after the operation, the aperture should be kept dilated by means of bougies; a gum-elastic or pewter tube, through which the feces are allowed to escape, may be fixed in the part.

Closure of Anus with Absence of Rectum.—It has already been stated that in some cases of perfect formation and of patency of the anus the rectum is absent, but more commonly the anus is closed when the whole of the rectum is wanting; the intestine (colon) terminating in a large and expanded pouch, situated high up at the brim of the pelvis, opposite the sacral prominence. A case of this kind differs from the last only in the extent of the occlusion, and cannot indeed be distinguished from it until the surgeon has made an incision in the site of the anus, and has failed to reach the gut at the usual distance from the surface.

Treatment.—In these cases three courses present themselves to the surgeon. 1. The colon may be opened in the left iliac region; 2. It may be reached in the left lumbar region; and, 3. An opening may be made into it through the perineum.

1. *Iliac incision.*—The only *advantages* that the iliac incision, or Littre's operation presents, are, that it is an operation easy of performance; and that, whether the surgeon reach the colon or not, he is certain to hit upon some part of the intestinal tube which may be drawn forwards and opened.

The *objections* to this operation are, the inconvenient situation of the artificial anus; the great danger that must necessarily result from wounding the peritoneum; the chance of not finding the sigmoid flexure; and, as has often happened, of being obliged to open that portion of the small intestine which first presents itself.

The *mortality* after this operation is very great. Amussat states that, of twenty-one children thus operated on, only four ultimately recovered; and it is worthy of remark, that all the successful cases occurred in the town of Brest.

2. *Lumbar incision.*—The lumbar incision, or Amussat's operation, has now been several times successfully practised on imperforate children.

The *advantages* of this operation consist not only in the artificial anus being situated at a more convenient spot than in Littre's operation, but more especially in the possibility of opening the colon in this situation without wounding the peritoneum.

The *objections* to this operation, as applied to imperforate children, lie in the frequent coexistence of malformation or malposition of the colon with absence of the rectum, and in the impossibility in many cases of determining, before proceeding to operate, whether the anus is only occluded by a membranous septum, or whether the rectum is absent as well. If it could be ascertained beforehand that, though the rectum be absent, the descending colon occupies its normal position in the left lumbar region, I think it probable that the lumbar incision would be attended with less danger than any other operation that could be practised; but, in the absence of this knowledge, it would scarcely appear to be justifiable to have recourse to it, as the colon might not be found, and the anus might merely be covered by a dense membranous septum.

3. *Perineal incision.*—The perineal incision has the advantage of being in the natural situation of the anus, and of being easily practised and perfectly successful in all those cases in which the anus only is imperforate, the rectum being present. It is in those cases only in which there is congenital absence of the rectum that this operation is difficult of performance, and uncertain in its results. The dissection requires to be carried with caution to a considerable depth along the mesial line; the surgeon taking the curve of the sacrum and coccyx for his guide, and, bearing in mind the relations of the bladder and large vessels in the neighborhood, carefully proceeding in search of the gut, which may be found at a considerable depth from the surface. Danger of wounding the bladder must also be considered, and may be

materially lessened by emptying this viscus by pressing over the pubes before commencing the operation. In four instances of this kind on which I have operated, it was necessary to proceed to a depth of at least one and a half or two inches before the bowel was reached; which, on account of the narrowness of the wound and the small size and important relations of the parts, is not an easy matter. If it could be ascertained before proceeding to operate, that the rectum is absent, it might be wiser to search for the bowel in the lumbar region. But, as the surgeon has no means of ascertaining, before making his incision, whether the rectum be one inch or three inches from the surface, he must cut into the perineum in order to obtain the necessary information; and if once he have penetrated to such a depth as to pass beyond the levator ani muscle, or into the deep fasciæ in this situation, a great portion of the immediate danger of the operation will have been incurred, and few would think it advisable to leave the perineal operation unfinished, and expose the child to the additional risk of opening the colon in the lumbar region. Yet, if he have gone as deeply as he dare venture, and have not encountered the bowel, there is no alternative but to open the intestine through the abdominal wall, or to leave the child to its fate. In this alternative, Amussat's operation should be performed. This has actually been done, and with success. I saw, some years ago, a young gentleman eight years of age, who had thus been operated on in Mexico for congenital absence of the anus and rectum. An incision had first been made in the perineum, but, no intestine being met with, the colon was opened in the left lumbar region. The boy was in good health, well nourished, had no great trouble with the artificial anus, which was covered with a truss pad, and only suffered occasional inconvenience from prolapse of the mucous membrane. There was a kind of sphincter-like action in the muscles about the orifice, by which the finger was griped.

I have twice operated in this way on imperforate children; but in both instances unsuccessfully. In one case, there was an anal aperture, but with complete occlusion of the rectum. I operated on the fourth day, first attempting to reach the gut through the anus; but, failing in this, performed the lumbar operation on the left side.

There is one point in connection with the perineal operation to which it is of much importance especially to attend, not only as respects the immediate result of the operation, but as regards the ultimate success of the procedure; I mean the bringing down of the mucous membrane of the gut, and fixing it to the lips of the external wound. Unless this be done, the line of incision between the termination of the gut and the aperture in the integuments will degenerate into a fistulous canal; which, like all fistulæ, will have a tendency to contract, and will be a source of endless embarrassment to the surgeon and to the patient. If the mucous membrane can be brought down and fixed to the opening in the integument, this source of inconvenience will be removed, and the patient will be saved all that danger which results from the passage of the meconium over a surface of recently incised areolar tissue. This, however, can only be done when the intestine terminates at a short distance from the surface. If the perineal incision be two or three inches in depth, there will be little probability of the surgeon being able to bring the intestine down to such an extent. In the case that I have related I attempted to do so, but found that the gut was too firmly fixed to be moved by any traction that it would have been safe to have employed.

Absence of Anus: Opening of Rectum into other Canals.—The anal orifice may be absent, and the gut may open into one of the neighboring mucous canals, as the vagina, the urethra, or the bladder. In such anomalous cases there is usually, I believe, but little to be done, except to restore the anal orifice if possible; but, if this be impracticable, to make a lumbar orifice, and then to take the chance of the other preternatural communication closing. This it will sometimes do; and cases have occurred in which, although the whole of the meconium with flatus had escaped *per urethram*, yet, on opening the rectum, the abnormal communication seemed gradually to close, the feces being directed into their proper channel. In a case in which I was once consulted, there was imperforate anus and rectum, and the bowel protruded as a red, fleshy tube, discharging meconium, and about four inches in length, from the anterior abdominal wall, just below the umbilicus, and immediately above an extroverted bladder. In such a complicated malformation, surgery could evidently do nothing.

STRICTURE—SIMPLE AND MALIGNANT.

Stricture may occur in any part of the large intestine, but with very varying degrees of frequency in different parts of that gut. Excessively rarely met with in the transverse, of unfrequent occurrence in the descending colon, it becomes more common in the sigmoid flexure, and very frequently occurs at about the junction of this portion of the colon with the rectum. In the rectum itself it is most commonly found either at the upper part, from four to six inches above the anus, or else a little above that aperture.

It is of two kinds: the Simple, consisting of mere thickening of the bowel, with fibrous degeneration of its coats and contraction of its canal; and the Malignant, dependent on cancerous degeneration of, or formations in the bowel.

Simple or Fibrous Stricture, though occasionally occurring in the transverse or descending colon, is most frequently met with at the junction of the sigmoid flexure and the rectum, or at the upper part of this gut, from four to six inches from the anus. Stricture of the large intestine commonly occurs in elderly people, and with special frequency in women. Not unfrequently a very tight annular stricture is found in otherwise healthy subjects, chiefly in young women, at the lower part of the rectum, about an inch and a half from the anal orifice: appearing almost as if it were the remains of a septum, or a thickened annular fold of the mucous membrane in this situation.

Symptoms.—The symptoms of stricture of the rectum consist at first of some difficulty in defecation, the patient being obliged to strain at stool. The feces will also appear to be flattened or narrowed, and in many cases, more especially as the stricture advances, are passed in the form of small scybala, with occasionally a kind of spurious diarrhœa, consisting of the passage of the more fluid intestinal contents, whilst the solid matters are left behind. At the same time there is very commonly pain in defecation, and the occasional passage of some mucus or blood; and dyspeptic symptoms, with flatulent distension of the abdomen, are apt to come on. If the stricture be within four or five inches of the anus, it may be reached with the finger, and its precise situation and diameter ascertained. If above this point, it must be examined by the introduction of a well-greased bougie, attention being paid to the curve which the rectum makes from side to side, as well as from before backwards. In introducing a bougie in order to ascertain the presence of a stricture above the upper end of the rectum, but little information can be gained in many cases, as the point of the instrument is apt to hitch in folds of the mucous membrane, or opposite the promontory of the sacrum; and thus, its onward passage being prevented, an appearance of constriction may present itself, which in reality does not occur, and unless care be taken the mucous membrane may actually be lacerated, and the instrument forced through it into the peritoneal cavity. In other cases, the bougie will appear to pass, when in reality its point, meeting with an obstruction, curves downwards into the rectum.

The *progress* and termination of a simple stricture vary in different cases. In some the contraction of the stricture may go on increasing, until at last complete occlusion takes place, with retention of feces and all the symptoms of obstructed bowels. This condition usually comes on slowly, and, after the obstruction is complete, life may continue for several weeks; but in some instances the obstruction seems to take place rather suddenly, and with all the symptoms of acute intestinal strangulation, death occurring in a few days. Abscess occasionally forms in the neighborhood of the stricture; and, passing down into the pelvis, may burst either into the ischio-rectal space, or into the vagina, or may present upon the nates. The discharge of pus from this source, as well as from the mucous membrane lining the stricture, which falls into an ulcerated state, may induce extreme emaciation and hectic, to which the impairment of nutrition consequent upon the disturbance of digestion adds materially. In some cases peritonitis will at last ensue, either in consequence of ulcer or abscess communicating with the serous cavity, or else from the extension of the irritation outwards.

Treatment.—The treatment of simple stricture of the rectum must be conducted on the principle of dilating the canal at its constricted point. If this be within reach of the finger, the dilatation can be readily carried out. If it be above the upper part of the rectum, and the stricture be tight, it is extremely difficult to introduce the proper instruments with certainty. When the stricture is low down,

so that the end of the finger can be introduced into it, it may readily be dilated by introducing a rectum bougie every second day, and gradually increasing the size of the instrument. If the stricture yield but slowly, and be very tight and indurated, I have found it a convenient plan to introduce a sheathed probe-pointed bistoury into it and to notch it towards its posterior aspect, where this may be done without danger to the peritoneum. A tent of compressed sponge should then be introduced, and left in for twelve hours. On its withdrawal, bougies may more readily be passed; or the dilatation may be carried on by means of tents of compressed sponge. When the stricture is above the reach of the finger, a good deal of management will be required to make the bougie enter it. This is best done by laying the patient on his left side, and using a moderate-sized wax or elastic bougie, which must be passed without the employment of any force. When once the surgeon has introduced one, others can readily be made to follow in the same track. The great danger in introducing a bougie high up, is to mistake the obstruction offered by its point coming into contact with one of the valvular folds of mucous membrane that occur in this situation, for that of the stricture, and, by pushing on the instrument, to perforate it—an accident that would probably occasion fatal peritonitis. During the introduction of bougies, the bowels must be kept regular by means of lenitive electuary, and the occasional use of emollient enemata. If much pain or irritation should be occasioned by their presence, opium should be administered internally or in the form of suppositories. Though a simple stricture of the rectum may be much relieved by the use of bougies, it is seldom, I think, cured by this means; there being a great tendency in it to contract so soon as the treatment is discontinued.

If complete obstruction occur, an endeavor should be made to relieve the patient by the use of enemata of gruel and linseed oil, and the strength should be supported by a diet that is nourishing, at the same time that it leaves little or no solid residue; the bowels may eventually act after a considerable lapse of time, the stricture apparently giving way. In a case which I attended with Mr. Powell, and to which reference has already been made, the stricture gave way after obstruction had lasted for about five weeks, some hardened feces with bloody mucus being discharged, which were speedily followed by abundant feculent motions. Should the obstruction, however, continue, and the patient consequently be in imminent danger of death from this cause, the intestine should be opened, if possible, by Amussat's operation, performed in the way already described (p. 998). This may require to be done either on the right or the left side, according to the seat of stricture. In the majority of instances, this will be situated below the descending colon, so that relief may be given by opening this intestine in the left loin; but if it be impossible or even very difficult to determine the precise seat of the obstruction, the operation may as readily be performed in the right lumbar region. In those rare cases in which the stricture is seated in the transverse colon, there would probably be considerable distension of the right loin, without any corresponding enlargement of the left; under these circumstances, the proper plan would be to open the cæcum.

Cancer and Malignant Stricture.—Cancer of the rectum usually occurs in the form of degeneration or infiltration of the substance of the wall of the gut, giving rise to considerable induration and contraction of the bowel. In other cases, a flat cauliflower growth springs from the inner surface of the intestine, being hard, nodulated, and presenting all the ordinary characters of scirrhus, or fibro-plastic; sometimes it is somewhat pedunculated, so as to resemble a hæmorrhoidal protrusion. Lastly, a scirrhous tumor may form in the areolar tissue external to the rectum, and at last press upon and implicate the gut.

Most usually cancerous disease is seated from three to five inches above the anus, and may implicate a considerable portion of the bowel, extending upwards rather than downwards, and giving rise to considerable induration and contraction, with complete occlusion of the interior of the gut.

Symptoms.—The symptoms of cancer of the rectum are pain and weight in the gut, with a sensation as if the bowels had not been completely relieved, together with the discharge of mucus, blood, or pus, and some flattening of the feces. On exploring the parts with the finger, the lower portion of the rectum will usually be found considerably expanded, whilst the tip of the finger will come into contact with the contracted, hardened, and rugged scirrhous mass. The patient experiences most suffering during defecation, in consequence of the passage of feces over the raw and ulcerated surface. This pain is not confined merely to the diseased part, where

the sensation is of a hot and burning character, but usually radiates round the loins and down the thighs, and is so severe, that the patient looks forward to each action of the bowels, with the greatest possible dread, and restrains it as long as possible. The whole nervous system at last participates in this continually recurring suffering; the countenance becomes anxious; the spirits are depressed; sleep and digestion are destroyed. The patient's condition is indeed truly miserable, between the dread of excessive suffering when the bowels act, on the one hand, and the fear of impending obstruction on the other; and in many instances he is worn out by this suffering, together with the constitutional cachexy induced by the contamination of the system with the cancerous matter. Not unfrequently the misery is much increased by the formation of fistulous openings in the neighborhood of the bowel, and communications between it and neighboring parts, such as the vagina, bladder, or urethra, with cancerous implication of them. In other instances, though more rarely, death occurs from fecal obstruction, as in the case of simple stricture.

Treatment.—The treatment must necessarily be palliative; large doses of opium being required after each action of the bowels to lessen the patient's distress. Little good can be expected from more active measures; dilatation only irritates the disease, and would tend to increase the mischief. The application of caustics, such as potassa fusa, does not offer much prospect of advantage, as only a superficial slough could in this way be formed without very serious risk to the patient, and it is an excessively painful remedy. Amussat has proposed to crush and break down the morbid mass by means of the finger and forceps; but from such treatment as this little good can be anticipated. The recommendation to excise the cancerous mass, as made by Lisfranc and other French surgeons, is contrary to every principle of good surgery; as it is impossible to extirpate the whole of the disease, without either laying open the peritoneal cavity, or destroying the patient by the profuse hemorrhage, which could scarcely be arrested. If palliative means fail in affording the requisite relief, and the patient suffer much local pain and constitutional irritation during defecation, the propriety of establishing an artificial anus in the left lumbar region may be discussed; not with a view of saving life, but rather in the hope of prolonging existence, and lessening suffering by preventing the exhaustion and agonizing pain that attend the passage of the feculent matter over the ulcerated surface (p. 997). In several instances much relief of suffering and considerable prolongation of life have been effected by this procedure.

Cancer of the Anus.—This is not a very common affection; it usually occurs secondarily in consequence of scirrhus of the rectum spreading to and involving the margin of the anus. When it occurs as a primary disease, it is usually in the form of epithelioma, and may then form about the anus, just as it does at other mucocutaneous apertures. If limited, and detected in the early stage, it might advantageously be excised; but at a more advanced period of the disease, such a practice can scarcely be adopted with any prospect of success, in consequence of the impossibility of removing the whole of the structures implicated.

Fibro-Plastic Tumor of the rectum is occasionally met with, forming large and somewhat pale tuberose masses, projecting into the interior of the gut, or even protruding through the anus, and giving rise to the same train of local symptoms as characterize cancer of the gut—although the pain is less intense. In such cases as these the disease may, if limited or pedunculated, be removed by double whipcord ligature or by the écraseur. By means of this instrument, I have removed from the inside of the gut a tumor of this kind nearly as large as the fist. Recurrence may of course be expected, but the patient will get relief for a time.

Polypi sometimes form in the rectum, constituting large pendulous tumors of a fibro-mucous character; they may most conveniently and safely be removed by the application of a ligature to their neck.

RECTAL FISTULÆ.

Fistulous openings occasionally occur between the rectum and the bladder in men; or between the gut and the vagina in women.

Recto-Vesical Fistulæ are not of common occurrence, and usually result either from organic disease of a cancerous character, establishing a communication between the rectum and the bladder; or from a wound of the gut during the operation of

the wet state in which the patient is kept by the dribbling of urine gives rise to an offensive ammoniacal odor about him. If the communication between the rectum and bladder be a free one, feculent matter and flatus get admission into the urinary organ, and escape from time to time by the urethra; perhaps even more abundantly than the urine does *per anum*. This is especially the case when the fistula is carcinomatous; and it is remarkable how little irritation is often set up by this admixture of feces with urine in the bladder. The fistulous aperture in the rectum can always readily be detected by passing the finger into the gut, or examining its interior with the speculum ani.

Treatment.—If the disease be cancerous, nothing can be done in the way of treatment beyond keeping the parts clean; but if it be traumatic in its origin, of small size, and more especially if it be recent, its closure may not unfrequently be accomplished by touching it with the nitrate of silver, or a red-hot wire through a speculum ani. In these cases, the platinum loop made red-hot by the galvanic current, according to Marshall's plan, might advantageously be employed. If, however, the fistula be of old standing, and the aperture large, cauterization will probably not succeed; and then perhaps the only mode of treatment that can be adopted will be to introduce a grooved staff into the urethra, and cut through the sphincter upon this, thus laying the parts into one, and converting the anal into a perineal fistula. By keeping the catheter in the bladder, and emptying this, granulations will be allowed to spring up, and deep union be accomplished.

Entero-Vaginal Fistula.—It has happened that a communication has been set up between the small intestine and the vagina, an artificial anus in fact forming in this cavity. These cases, however, are very rare, and may indeed be looked upon as incurable; for though some of the French surgeons, as Roux and Casamayor, have endeavored to establish, by a deep and difficult dissection, a communication between the small and large intestine, the operation, as might have been expected, has proved fatal.

Recto-Vaginal Fistulæ are usually the result of sloughing of the posterior wall of the vagina, in consequence of some undue pressure exercised upon it during parturition. They are of two kinds; viz., the simple, and those complicated with more or less extensive laceration of the perineum. The size of these fistulous openings, when uncomplicated with rupture of the perineum, varies greatly; in some cases there is merely a small perforation, in others there may be loss of the greater portion of the posterior wall of the vagina. Whatever their size, they are necessarily sources of very great discomfort and annoyance, both physical and mental, to the patient. The recognition of the disease is of course at once made; the escape of the feces and flatus into the vagina being obvious, and digital or ocular examination through the two-bladed speculum at once detecting the seat and extent of the aperture. As there is just the possibility of the communication existing between the vagina and the small intestine, it may be useful to bear in mind that, in this case, the feculent matter that escapes has been found to be yellower and less stercoraceous than when the rectum is opened.

The *treatment* will vary according as the fistula is simple or complicated with lacerated perineum.

Simple uncomplicated recto-vaginal fistula, if it be small and recent, may occasionally be closed by attention to cleanliness, at the same time that its edges are touched with the nitrate of silver, a hot iron wire, or the platinum loop. If it be very large, the greater part of the posterior wall of the vagina having been destroyed, it will probably be incurable; but even here the patient should not be left to her fate, and some operation should be attempted which may lessen its size, even if it do not completely close it. The kind of fistula which is here most commonly met with usually consists of a circular aperture, that readily admits the point of the finger, as it is situated just above the sphincter ani. The operation for the closure of a recto-vaginal fistula of this kind consists, after emptying the patient's bowels by purgatives and an enema, and the bladder by the catheter, in introducing a duck-billed speculum into the vagina, and freely paring the edges of the aperture. As the fistula is always low down, this is readily done by placing the patient on her back, and tying the hands and feet together, as in lithotomy. The vaginal mucous membrane should be dissected off towards the fistula. The next point is to bring

its edges into apposition, in a direction transverse to the axis of the vagina; and in doing this, the recommendation made by Copeland and Brown, of dividing the sphincter ani, should always be acted on, as it is a most important auxiliary to the success of the operative procedures that are required; for, as there is always loss of substance in these fistulæ, there is necessarily a tendency to tension on their sides when any attempt is made to draw them together; and it is also of importance that any muscular movement about the parts in the neighborhood of the fistula should be arrested, as this might otherwise break down union after it had taken place between the edges. The sides of the fistula must then be drawn into apposition by silver sutures introduced by means of the hollow needle. I have generally found that these sutures are most easily introduced if passed *from above downwards*—the mucous membrane being then drawn upon by the needle, which more readily transfixes it than if it is introduced from below upwards, when it is left to push the membrane before it. The wires are then passed across the fistula and out through the vaginal mucous membrane, half an inch beyond the freshened surfaces, care being taken not to include the rectal mucous membrane. They may then be twisted, or brought through a leaden plate and clamped by shot. The success of the procedure depends not only on the proper completion of the steps of the operation, but greatly on the after-treatment. This should consist in the administration of opium, to prevent the bowels from acting for ten or twelve days; indeed, until firm union has taken place between the edges. They may then be moved by means of laxatives and oleaginous enemata carefully given. During the treatment the parts should be disturbed as little as possible, the patient lying on her side with a gum catheter tied in the bladder. The parts should be well syringed twice a day with cold water. The patient must be kept upon a very moderate diet, and the stitches may be left in for eight days, when they must be cut out and carefully removed. Should any point of the fistula not be closed, the application of the nitrate of silver may induce proper union of it.

If, as very commonly happens, the *recto-vaginal fistula be complicated with a lacerated perineum*, the operation for that condition, described at p. 414, must be performed, and the edges of the fistula, being deeply pared, brought together at the same time. Sometimes in these cases it happens that the perineum unites, leaving an aperture above this in the recto-vaginal septum; if this aperture be but small, it may be closed by its edges being touched from time to time with the actual cautery; if it be large, so as to allow the introduction of the finger, I believe that it is generally useless to attempt to close this aperture by itself; but the perineum should again be divided, and the whole operation repeated.

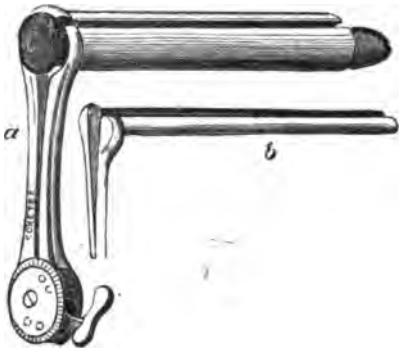
ULCER AND FISSURE OF THE ANUS.

This disease, though trivial in point of size and in its pathological relations, is of great practical importance, on account of the excessive local pain and great constitutional irritation to which a patient laboring under it is often subject. Ulcer and fissure commonly exist together in this situation, though it by no means unfrequently happens that the two conditions occur separately. The ulcer is usually of small size, seldom larger than a silver threepence, of a circular or longitudinal shape, situated between the folds of the mucous membrane in the upper part of the anus, or rather the lower part of the rectum, just above the ring or ledge formed by the sphincter, and is usually met with towards the posterior part of the gut on one side of, or opposite to, the point of the coccyx. Occasionally more than one ulcer exists in this situation. If a fissure accompany the ulcer, it commonly leads from this across the face of the sphincter to the verge of the anus; but in many cases one or two fissures, sometimes even three or four, exist without any ulcer. The fissures are usually slightly indurated and cord-like, extending merely through the mucous membrane, scarcely if at all, implicating the deeper structures; and not unfrequently their external termination is concealed by a small red pile or flap of integument.

The existence of the ulcer may usually be determined by exploring the rectum with the finger, which, if practised in these examinations, will detect a small, soft, and velvety patch at the diseased spot; on touching this the patient will usually complain of acute and burning pain. In some cases the ulcer may be brought into view by examining the rectum with the speculum ani, as here delineated (Figs. 501 and 502). The fissure may always readily be detected by everting the mucous mem-

brane of the anus, and by lifting up or turning aside the pile that covers the lower end of the crack. During this examination, it will usually be found that the sphinc-

Fig. 501.



Anal dilator.

Fig. 502.

Speculum ani.

ter ani is in a more or less spasmodically contracted state, admitting the finger and instrument with difficulty.

Symptoms.—The symptoms of ulcer or fissure in the anus are very characteristic. The patient complains of pain, usually of a severe burning character, on the passage of a motion, especially if a hard one; occasionally it occurs at the time of defecation, but more frequently commences a few minutes afterwards, and continues from half an hour to several hours. This pain is very severe, and peculiarly wearing and burning; it is generally most felt opposite the sacro-iliac articulation, but not unfrequently radiates round the pelvis or down the thighs. In many cases it produces a good deal of continued irritation about the genito-urinary organs, giving rise to symptoms of spasmodic stricture; a frequent desire to urinate, tenderness about the prostate, and seminal emissions. The pain is sometimes so severe that the patient avoids defecation as long as possible, and even abstains from food with the view of lessening the necessity for the frequency of this act. Very commonly in women, the pains produced by the rectal disease simulate those occasioned by uterine irritation; and in both sexes they may after a time become continuous, and be attended by a good deal of constant uneasiness in sitting, so that the patient is obliged to raise the affected hip. There is often a discharge of a streak of pus or blood on the feces, and commonly a good deal of mucous exudation, with some tenesmus on defecation; but in some instances these symptoms are altogether absent, and the patient never suffers any local inconvenience except from the pain.

The constitutional irritation is often very great, the nervous system generally sympathizing with the local mischief. The countenance becomes pale, anxious, careworn, and the patient's expression is indicative of constant suffering.

Causes.—This affection most commonly occurs in women, especially in those of an hysterical temperament and weakly constitution. When met with in men, it is most frequently seen in enfeebled, cachectic, and debilitated subjects, and appears to be the result of a broken state of health. In persons who have been the subjects of the chronic dysentery of hot climates, I have several times noticed a peculiar form of patchy ulceration within the rectum, of an extremely irritable and very intractable character. I have in several instances observed it in women to be of a syphilitic nature, and in such cases it is situated generally towards the side or the anterior part of the anus.

Treatment.—The treatment of fissure or ulcer of the anus, when the disease is met with in the early stages, may sometimes be successfully conducted by the application of nitrate of silver to the fissure, and the use of an anodyne or astringent suppository. I have found a very excellent and useful suppository in this and many other painful affections of the anus to be composed of 2 grains of extract of belladonna, 2 grains of the acetate of lead, and 4 of tannin, made up to a proper consistence with a little suet. This may be introduced into the rectum every night

and allowed to dissolve there; the bowels should at the same time be kept gently open with castor oil, or the lenitive electuary. In those cases in which the disease has been of some standing these means will not suffice, and it becomes necessary to have recourse to a very simple operation to effect a cure. This consists in dividing the affected mucous membrane through the ulcer or fissure, with possibly some of the subjacent fibres of the sphincter muscle, by which the part is set at rest, and cicatrization speedily takes place. The relief after the operation is usually immediate; indeed, after its performance, a patient who has been suffering severely for months or years, will often get complete and almost instantaneous relief. The merit of introducing this plan of treatment for the cure of ulcer and fissure of the anus into surgical practice is due to Sir B. Brodie. Boyer had previously recommended that the sphincter should be cut completely across, in order that its action might be paralyzed; but Brodie found that the ulcer could be made to heal as readily by the limited incision above mentioned. The operation is readily done by introducing the left fore-finger into the rectum, guiding along it a probe-pointed bistoury, and then cutting downwards and outwards, carrying the knife about the eighth of an inch in depth. No dressing is required after this operation; but, if the incision do not readily heal, it should be touched from the bottom with the nitrate of silver. The patient's bowels should be well opened before the operation, and a dose of castor oil may be given on the second or third day after it. During the process of cicatrization it will often be advantageous to give iron, and to put the patient on a nourishing diet.

Spasmodic contraction of the sphincter ani is usually associated with fissure or ulcer of the anus: but occasionally it occurs without this complication, and in all cases it may be connected with a neuralgic condition of the part. In hysterical women, this neuralgia and spasm are especially apt to occur; though it is not improbable that in many of the so-called cases of neuralgia of the anus, some positive disease, such as a small ulcer or fissure, may be detected on close examination, as I have had several occasions to verify.

The *treatment* of spasm of the sphincter, whether associated with neuralgia or not, consists in the employment of local sedatives, enemata, and laxatives, with, if necessary, the division of a few of the muscular fibres, together with the mucous membrane.

ABSCESS AND FISTULA.

Abscess not unfrequently occurs in the vicinity of the rectum and anus. It may either be superficial, being confined to the muco-cutaneous structures, and presenting the ordinary characters of acute subcutaneous abscess; or it may be deeply seated, forming in the ischio-rectal fossa. It is these rectal abscesses that are of most practical importance. They may be of two kinds—*acute* and *chronic*.

Acute ischio-rectal abscess.—This forms deeply in the fossa, with throbbing, shooting, and stabbing pains through the anus, rectum, and perineum; on examination, a hard brawny substance may be felt in the areolar tissue by the side of the gut, either by examination from without, or by exploration through the rectum, which speedily softens, and will, unless an outlet be made for it, either burst externally, or into the cavity of the gut, or both ways. This acute form of abscess usually occurs in persons of otherwise strong and healthy constitutions.

Chronic ischio-rectal abscess, on the other hand, occurs insidiously in persons of cachectic, broken, or phthisical constitutions. Without much pain or local inconvenience, it forms a collection of pus, which is usually limited to one side of the ischio-rectal fossa, but in other cases acquires considerable magnitude, denuding the gut to a considerable extent; in fact, almost surrounding the rectum, and then spreading widely on the nates or hip, presenting all the ordinary characters of a chronic abscess. This kind of purulent collection may form in this as in any other situation in the body, as the result of congestion or of some local irritation. I have several times seen it follow kicks, blows, or bruises of the lower part of the body, or as a consequence of the lowering of the vitality of the mass of cellulo-adipose tissue on the ischio-rectal fossa by weakly persons sitting on a cold stone, or standing for a long time on the ice or snow. In other cases the mischief appears to originate around the prostate, and an abscess forming in this situation may find its way down by the side of the rectum. Sir B. Brodie attributed these ab-

scesses, and the consequent fistulæ, to perforations of the mucous membrane of the gut; and although I think he exaggerated the frequency of this mode of production of the abscess, yet there can be no doubt that, in some instances, at least, it occurs as the result of perforation of the bowel; either by ulceration from within, by the formation of a fissure, or by some foreign body, as a fish-bone, transfixing it, and thus inducing inflammatory action in the areolar tissue outside the rectum.

Treatment.—In the treatment of these abscesses, the principal point to be attended to is to prevent the extensive denudation of the gut. In order to do this the abscess must be opened, so soon as the formation of pus can be ascertained to have taken place, by making a free, and, if necessary, a deep incision into the ischio-rectal space by the side of the bowel. Unless this be done, it may either burst into the interior of the gut, or spread widely upon the nates, and then give way. The pus that is let out of these collections is always extremely offensive, even though not mixed with any feculent matter; the near neighborhood of the bowel appearing to determine some change in it that renders its smell peculiarly stercoraceous. After the evacuation of the abscess the patient feels easy, and thinks that all is well, the discharge gradually lessening and the cavity contracting; but it does not close, and a fistula will be left, which continues to exude a thin watery pus, in which feculent matter, perhaps, accumulates from time to time, giving rise to fresh outbreaks and extensions of the disease.

Fistula in Ano.—The sinus left by the contraction of the cavity in an ischio-rectal abscess constitutes a *fistula in ano;* an affection that has attracted a good deal of attention from the frequency of its occurrence, and from the difficulty of curing it without having recourse to operation.

Extent.—Some fistulæ are very limited, being merely the sinus left in the submucous areolar tissue of the anus after the bursting of a superficial abscess in this situation, extending to a short distance up the gut inside the sphincter. This form of fistula constitutes, however, a kind of spurious variety of the disease; for the true fistula in ano is outside the sphincter in the surrounding areolar tissue, extending always as high as the upper margin of that muscle, and frequently stretching to a considerable distance up the side of the gut. Most frequently the lower and external aperture of the fistula is single, and is situated by the side of the anus in the ischio-rectal fossa, just beyond the sphincter; but not unfrequently the aperture is in the perineum, or posteriorly in the coccygeal region. Occasionally there is a fistulous opening on each side of the gut; or several openings may exist, and then sinuses extend from these upwards and outwards to a considerable distance, undermining the integuments of the perineum about the buttocks, even stretching away towards the trochanters, and opening at a great distance from the bowel. These extensive fistulæ and sinuses are frequently connected with stricture of the gut; but they may occur without this in old and neglected cases of the simple disease.

The fistulæ are usually oblique, but straight in their direction from a point half an inch or an inch from the anal aperture, running upwards to above the sphincter. In some cases they are tortuous; and occasionally, when opening at a distance from the gut, and extensively undermining the integuments, they are angular, having, as it were, an elbow at that point where the superficial sinus meets the deep fistula. This peculiarity will prevent the passage of a probe through their whole length until the external sinus has been slit up, and the commencement of the deep fissure reached, and may lead to the supposition of the fistula being more superficial than it in reality is.

Varieties.—Fistula in ano is said to be *complete* when it communicates by one end with the interior of the rectum, and opens by the other upon the external surface. It is said to be *incomplete* when it has only one aperture, whether that be external or internal.

Complete fistula is the most common form. It probably arises in the majority of cases from some source of irritation seated within the bowel, by which the mucous membrane of the rectum has been perforated, and an abscess has formed in the areolar tissue outside the gut. The external opening in this form of fistula is usually from half an inch to an inch from the margin of the anus; though it may be seated at a greater distance than this, as upon the hip. It is commonly small, and has a vascular granulation projecting from or occluding it; and a thin purulent discharge usually drains away from it in small quantities, moistening the surrounding integu-

aperture, for in the majority of cases it runs up into a kind of *cul-de-sac*, to a considerable distance further. The internal aperture may readily be detected by introducing a blunt curved probe into the fistula; when, by a little management, it may be carried through the inner opening. In some cases, the existence of this may be ascertained by examining the interior of the bowel with a speculum ani, and by injecting water into the external opening.

Incomplete or *blind fistula* may be of two kinds, and commonly arises from constitutional causes. When there is no internal perforation, a mere sinus having been left by the bursting of an abscess, the fistula is termed *blind external.* When there is only an internal aperture, it is called *blind internal.* The blind external fistula is readily recognized by its being found that the probe does not penetrate the interior of the gut. The blind internal is not so readily detected; but in this case it will generally be found that the patient suffers from an occasional and tolerably abundant discharge of pus from the interior of the bowel; that there is a good deal of tenderness, with some brawny induration in the ischio-rectal fossa on one side of the anus; and that the pus may be made to well out in some quantity by pressing upon this part. On passing the finger into the rectum, the ragged internal aperture in the gut through which the pus exudes may readily be felt.

Treatment.—Operative interference is usually necessary. It is true that in some rare instances the fistula may be made to close under the influence of constitutional management, aided, perhaps, by stimulating its interior with the nitrate of silver, or by touching it with a probe dipped in nitric acid. This kind of treatment is, however, only successful in the blind external fistula, several instances of which I have seen recover in this way; but it can never be expected to answer in any other variety of the disease. Occasionally in elderly people a blind internal fistula (or fistulæ) will be found, which, falling into a very chronic state and discharging but little, is a source of but very trivial discomfort, and will continue for years without giving the patient serious local inconvenience, and in no way disturbing the general health. In such cases, I believe, there is often far less risk in leaving the fistula untouched, than in subjecting the patient at an advanced period of life to the hazards of an operation. When the fistula is complete, the only plan of treatment that offers any chance of success is the division of the sphincter; so that this muscle, which tends to prevent the closure of the sinus, may be paralyzed, and the fistula, being laid open from the bottom, made to heal by granulation. Various plans have been devised for the division of the sphincter, and much ingenuity has been expended in attempts to discover simpler and less painful modes of effecting this than by the knife, but hitherto without success; and the only plan of treatment that deserves any attention is the division of the sphincter with a curved bistoury.

The *operation* for fistula in ano should not be performed indiscriminately in all cases and at all periods of the disease. If the fistula be dependent upon stricture of the gut, and more especially if this be of a malignant character, it is evident that no operation can be attended by a chance of success, and none should be attempted. So, also, if the patient be cachectic and broken in health, it is well to improve his constitutional powers before undertaking an operation, lest the wound that results may not readily cicatrize. It is also well to wait until the disease has assumed a somewhat chronic form before proceeding to the division of the sphincter; if this be done early after the bursting of the abscess, or at any time if there be much inflammatory action going on, the wound is apt to assume a somewhat sloughy condition, and to heal with great difficulty. The most important question usually connected with the operation for fistula, is the propriety of performing it in phthisical subjects. It is a well-known fact that fistula in ano is especially apt to occur in consumptive individuals, and it is often a nice point to determine whether an operation should be performed or not in them; how far the drain from the fistula may keep up or even generate the tendency to phthisis, or how far it may be salutary in acting as a counter-irritant, and in preventing the morbid condition of the lung from developing itself. Theophilus Thompson has stated that the coexistence of fistula with phthisis appears to retard the progress of the latter disease, acting as a derivative; and doubtless in some instances this may be so. I have however, in several cases found considerable advantage result from operating for

fistula in the early stages of phthisis, or in suspected cases of that disease, the patient's health having considerably improved after the healing of the fistula. In such cases, it may be of use to put an issue in the arm or side of the chest. But in confirmed, and still less in advanced phthisis, no operation should ever be practised; as the wound will not heal, and the patient must be weakened by the additional discharge.

The operation for *complete* fistula should be performed in the following way. The bowels having been well cleared out the day before with a dose of castor oil, and an enema administered on the morning of the operation, the patient should be laid on his left side, with the nates projecting over the edge of the bed; a probe must then be passed through the fistulous track into the rectum, and the surgeon, introducing the forefinger into the gut, feels for the end of the instrument; he then passes a short strong-bladed probe-pointed bistoury of about the size and shape of that represented in the annexed figure (503), through the fistula, using the probe as a guide, though in some cases this may conveniently be dispensed with. When he feels the end of the knife projecting into the rectum through the internal aperture of the fistula, he withdraws the probe, hooks his forefinger over it (Fig. 504), and by a sweeping and pressing cut, raising the handle of the instrument at the same time that he pushes down its point, brings both finger and blade out at the anal aperture, cutting through the whole thickness of the parts between this and the fistula, so as to lay the two cavities into one. Care should be taken to divide the sphincter in a direct and not an oblique manner, lest a flap or fold be left which will interfere with the proper healing of the wound. In performing this operation, the surgeon should cut with his left hand if the fistula be upon the left side; and in either case should be careful not to wound his own finger, as such cuts often prove troublesome in healing. Where the external aperture or apertures of the fistula are at some distance from the gut, the integuments being undermined to a considerable extent, perhaps thinned soft and bluish, all the superficial sinuses should be slit up; and, in those cases in which the course of the fistula runs more or less at a right angle with that of the external sinus, it is necessary to do so before the deep or internal fistula can be reached, through which the sphincter must be divided. If the fistula be a *blind external* one, it must at the time of the operation be made complete, by scratching with the end of the knife through the thinned structures that intervene between its extremity and the interior of the gut; and the operation must then be completed in the way described. If it be a *blind internal* fistula, a bent probe should be passed up the anus and through the inner opening of the fistula into the canal. The end of this, which can be felt externally, must be exposed by a puncture made through the integuments with a sharp-pointed bistoury, and the operation then concluded in the ordinary way.

Fig. 503.

Probe-pointed bistoury for fistula.

Fig. 504.

Operation for fistula in ano.

When there is an internal aperture into the gut, this will usually be found just above the sphincter; but the fistula does not terminate here, frequently extending up by the side of the gut for an inch or two. In these circumstances, what should be done with the *cul-de-sac* above the inner aperture? If it be laid open, an extensive and deep wound will be inflicted, which may implicate some of the hæmorrhoidal vessels, and thus give rise to a dangerous amount of bleeding. Hence I think it a safer practice for the surgeon to content himself with the division of the sphincter and all the parts intervening between the inner aperture of the fistula and the verge of the anus; the sinus which is left usually contracting and closing without difficulty when this has been done. In some cases it happens, however, that this *cul-de-sac* is not readily obliterated, but gives rise to a good deal of trouble in consequence of the occasional accumulation of pus in it, and the thickening of its aperture into the bowel giving rise to spasmodic contraction of the sphincter and a kind of rectal stricture. This inconvenience gradually subsides in most cases, by the use of astringent injections or the introduction of a probe armed with nitrate of silver. If

the integuments around the fistula have been much undermined and thinned so as to leave loose flaps at the edges of the incision, the cure will be materially hastened by cutting these off.

The after-treatment should be as simple as possible, consistently with securing closure of the wound by granulation from the bottom. A narrow slip of oiled lint should be introduced between the lips of the wound, and this must be left in for forty-eight hours, during which time the bowels are kept confined by the administration of a grain or two of opium immediately after the operation. On the second day a dose of castor oil may be administered, which will not only act upon the bowels, but bring away the piece of lint. The wound must then be lightly dressed from the bottom, a poultice applied, and care taken at the daily dressing, by the introduction of a probe, to prevent the bridging over of granulations. After the wound has completely united, a notch will usually be left by the side of the anus, which gives rise to some inconvenience for a time by the occasional involuntary discharge of a little intestinal mucus, and some flatus. This especially happens in those cases in which the incision has been made anteriorly to the anus into the perineum, and where incontinence of feces may, for a time, be left. Should an inconvenient or dangerous amount of hemorrhage occur at the time of the operation, the wound should be plugged with dry lint, and a firm pad applied by means of a T-bandage. Should profuse bleeding, in consequence of the division of some of the hæmorrhoidal vessels, come on a few hours after the operation, all coagula should be cleared away, the gut washed out with ice-cold water, and then securely plugged either with a piece of compressed sponge, or with a bougie, surrounded by lint soaked in a solution of perchloride of iron.

[An operation for fistula in ano, which is slightly different from that described by the author, seems to me both simpler and easier of execution. A flexible grooved director is used instead of a probe, and the surgeon having found the internal orifice of the fistula, or made such orifice if the fistula be incomplete, brings the extremity of the director out through the anus. The sphincter is then raised upon the groove of the director, and can be divided with a single stroke of a sharp scalpel. This plan enables the operation to be more quickly completed than the other, and is therefore attended with less pain, while it has the additional advantage of in no way endangering the surgeon's fingers.—A.]

HÆMORRHOIDS, OR PILES.

By *hæmorrhoids*, or *piles*, is meant a morbid condition of the bloodvessels of the anus and lower part of the rectum, especially of the veins of the submucous and subcutaneous areolar tissue, giving rise to more or less intumescence of the part, which may or may not be attended with a discharge of blood. Surgeons are commonly in the habit of classifying piles, according as they bleed or not, into *open* or *blind;* or, according as they are situated above or below the verge of the anus, into *internal* or *external:* the internal being always within the gut, the external habitually protruding out of or around the anal aperture. The first may either bleed or not; the latter are always blind. To this division into external and internal, B. Cooper has added an intermediate variety, the *intero-external*, which is partly within and partly without the anus. These divisions are of much practical moment, as the treatment is very materially modified according as the hæmorrhoid is situated above or below the anal verge.

Predisposing Causes.—We must look to the peculiar *arrangement of the veins of the rectum* as directly predisposing to the occurrence of piles. The lower part of the rectum and the verge of the anus are composed of a plane of muscular fibre and a muco-cutaneous surface, with an intervening stratum of dense areolar tissue. In this areolar membrane is situated a close interlacement or network of tortuous veins. The blood, from this plexus of hæmorrhoidal veins, finds its way into the general system through two distinct channels. By far the greatest portion of it is carried into the inferior mesenteric vein, and thence into the vena porta, through the medium of the superior hæmorrhoidal vein, which may be looked upon as the extreme radicle of the portal system; and a certain quantity passes into the internal iliac vein through branches that accompany the middle hæmorrhoidal artery. We may, therefore, look upon the hæmorrhoidal plexus as being placed midway between

the portal and general venous systems, being the point indeed at which they touch; but as belonging rather to the portal than to the systemic veins. In these arrangements we see all the elements that would predispose to congestion, and consequent dilatation of the vessels of a part. There is a large and intricate plexus of veins in which, as in all similar networks, there is a tendency for the blood to circulate slowly at times; the natural tendency to stasis of the blood being much increased by the dependent position of the part, and by the anatomical fact that, in consequence of the absence of valves in the superior hæmorrhoidal vein and in the vessels into which it pours its contents, the whole pressure of the column of blood in the portal system may be brought to bear upon the hæmorrhoidal plexus. The circulation through the portal system is likewise subject to much interference in consequence of hepatic and intestinal obstruction, and in these changes the blood in the hæmorrhoidal plexus also participates; and, were it not for the provision that exists by which this plexus may free itself to a certain extent from over-distension by its communication with the internal iliac through the medium of the middle hæmorrhoidal vein, piles would be much more frequent than they even now are, as a consequence of obstructed portal circulation. Another great cause of hæmorrhoidal enlargement is to be found in the want of support that the veins of this plexus experience on their mucous aspect during defecation. Situated as they are in areolar tissue, between a plane of muscular fibres on one side, and yielding mucous membrane on the other, when distended by the constriction which they undergo during and after the expulsion of the contents of the rectum, they necessarily give way on that side on which they have the least support, being forced down and elongated, together with the mucous membrane under which they ramify, and which has a natural tendency to become slightly everted during the act of defecation. It will be found that all the more immediate or exciting causes of piles act by unduly increasing one or other of those natural tendencies that exist in the system, by favoring the local congestion or determination of blood, at the same time that they produce a lax state of fibre.

Age exercises considerable influence in predisposing to piles. This disease is not unfrequently met with in young men of eighteen or twenty years of age; more especially if they be of a relaxed and phlegmatic temperament with languid circulation, and be obliged to lead a more sedentary life than is natural or proper at that age. After this period, the liability to the disease diminishes until middle age is reached, when the tendency to hæmorrhoidal affections is again increased, and becomes more marked than at any former period of life, owing to the more active operation of those causes that tend to impede the return of the portal blood.

Sex appears to exercise more influence on the occurrence of hæmorrhoids at particular periods of life, than on the general liability to the disease. It certainly appears to be more frequently met with amongst men at an early age, than in young women; but at a later period of life, so far as my observation goes, the disease occurs with nearly equal frequency in both sexes. The comparative exemption of young women is readily accounted for, by the periodic discharges from the uterus preventing the congestions that might otherwise occur in the parts in its vicinity. The greater frequency in females at a latter period of life is attributable not only to the tendency induced during pregnancy by the pressure of the gravid uterus, but also, after the cessation of the menses, to the determination that is apt to be set up in certain organs of the female economy, and to the retardation of the portal circulation by the accumulation of fat and other causes; these conditions chiefly occur in women of a sanguine and plethoric habit of body.

A *sedentary life* with indolent habits constitutes, perhaps, the most powerful predisposing cause of the disease; more especially if habitual high living be conjoined with want of proper and sufficient exercise. Indeed, the artificial and luxurious habits of the more opulent classes, by diminishing tone at the same time that they occasion plethora and a tendency to abdominal engorgement, exercise a considerable influence on the occurrence of this disease, which is much more frequent amongst them than in persons in the humbler walks of life.

There are a number of minor conditions which are commonly looked upon as predisposing causes of this disease, though it is extremely difficult to determine the precise share that each has in its occurrence. Amongst these may be mentioned intemperance in food and drink; residence in warm, moist, and relaxing climates;

the use of soft and warm beds; or the opposite condition of sitting on a cold stone or damp cushion. Over-excitement of the generative organs will also occasion it.

Exciting Causes.—Amongst the exciting causes may be mentioned *local irritation* of any kind. Thus, in some people hard riding will bring on an attack of piles. The *habitual use of drastic purgatives*, more especially of aloes, rhubarb, &c., is well known to occasion the disease; though it must be observed that individuals, who make habitual use of these remedies, often labor under some of those obstructions of the abdominal viscera that have already been noticed as conducing to piles. The existence of other *diseases about the rectum and anus*, such as fistula, ulcer, or stricture, by inducing local congestion and irritation, may excite the disease; so also, *uterine affections* and various *diseases of the genito-urinary organs* may give rise to this affection.

[Stricture of the urethra is a frequent cause of hæmorrhoids, and I have even known an attack of piles brought on in persons disposed to the affection, by the accident of not being able, from the exigencies of society, to empty the bladder for an hour or two later than usual.—A.]

The most direct exciting cause of piles is certainly a *retardation to the return of the portal blood.* Any impediment to the onward current of the blood through the hæmorrhoidal or mesenteric veins, the trunk or ramifications of the vena porta, exercises a marked influence on the tendency to congestion of the hæmorrhoidal plexus. Habitual constipation; the accumulation of hardened feculent masses in the large intestine; the want of due secretion from the mucous surface; obstruction to the proper action of the liver, and consequent congestion of that organ; the pressure of abdominal tumors, or of the gravid uterus, are all active exciting causes, interfering as they do with the proper return of the portal blood. In some cases, even the existence of an obstacle to the circulation in the systemic veins may occasion this disease; thus it will arise from the pressure of an aneurismal tumor on some of the larger venous trunks within the chest.

Structure.—A pile, whether external or internal, consists essentially in the first instance of a varicose condition of a portion of the hæmorrhoidal plexus, or rather, of the small veins of the submucous tissue that pour their contents into this; this varicose condition, becoming prominently developed at certain points, gives rise to small knots or tumors. A pile in this state is quite soft and compressible, and can readily be emptied by pressure; and when cut into, it will be found to be composed of one or more cells filled with blood, and surrounded by areolar tissue. The appearance of cells is, however, deceptive, and is occasioned by a section of the sacculated and dilated veins that enter into the composition of the tumor. After the piles have existed for some little time, or after they have once become inflamed, the tissues that enter into the composition undergo modifications that induce corresponding alterations in the character of the tumor. The coats of the veins become thickened; their cellular dilatations are filled with coagulated blood; the investing areolar tissue is hypertrophied or thickened by plastic deposit; and, on being cut into, the pile is seen to be composed of a spongy kind of tissue filled with blood. External piles, when examined after removal, often resemble in structure a mass of hypertrophied areolar tissue, infiltrated with plastic matter, in which a number of small vessels of uniform character ramify, but without any appearance of cells. Internal piles, on the contrary, contain more of the venous, and less of the areolar element. They are also commonly furnished with a small central artery, which is apt to bleed freely, or even dangerously, if the tumor be cut across; hence, provided they are not clogged with coagulated blood, they may readily be injected from the inferior mesenteric artery.

In studying the structure of hæmorrhoids, it is of importance to observe that they occur under two different forms: one in which there are distinct tumors, within or external to the anus, and another in which there is merely a varicose condition of the veins of this region, without distinct intumescence.

In those cases in which there is merely a general varicose state of the veins of the submucous areolar tissue of the anus, without any distinct tumor springing above the level of the membrane, it will be found that the smaller branches of the hæmorrhoidal plexus, and the small twigs that enter these from the submucous areolar tissue, have undergone varicose dilatation, being apparently greatly increased in number, as well as in size. The mucous membrane is of a deep mulberry or port-wine color, and becomes everted after each motion. There is usually some mucous secre-

lumbar region, or in the thighs. The motions, more especially if hard, are streaked with blood, and more or less of this fluid drops in a rapid manner after the passage of the feces. There is seldom much blood lost; but at times there is an exacerbation of all these symptoms, and the hemorrhage, as will more particularly be mentioned hereafter, may become very abundant. This condition of the mucous membrane may precede, and is frequently found to accompany the true pile, whether external or internal, and may be looked upon as constituting the first stage of this disease. If this state of things be allowed to continue unrelieved, the tendency to congestion increases; more and more of the mucous membrane becomes everted and protruded after defecation; the submucous areolar tissue becomes stretched and lax, and the case is apt to become one of prolapsus ani.

External Hæmorrhoids are those that are situated below the verge of the anus, and that are invested by cutaneous, or, at most, by muco-cutaneous tissue. Before appearing as defined tumors, they usually constitute longitudinal folds that surround the anal aperture, or radiate from it as from a centre. In color, they vary from that of the natural structures to a pink or purplish hue; and their tegumentary covering consisting of the thin skin of the part, they resemble folds of this tissue rather than of mucous membrane. Their size varies, according to the state of congestion; and hence the same tumor may at one time be soft, flaccid, and loose, apparently nothing more than a fold of integument, and at another may become tense, tumid, and ready to burst.

Symptoms.—When of small size and recent formation, external piles do not in general give rise to much distress, but merely some local heat, pricking, and itching, with a sense of fulness after defecation; but when of large size, and inflamed or irritated, they may occasion very acute suffering. There is not only deeply-seated, dull, aching and throbbing pain in the pile itself, but this shoots up the side of the rectum, through the perineum, and into the nates, and is much increased when the patient stands or walks. After a few days these symptoms subside; suppuration either taking place in the pile, or the blood contained in it coagulating. The parts are, however, left in a thickened and indurated state, and do not really assume their former soft and flaccid condition, effusion of plastic matter taking place into the areolar tissue, and the contained blood perhaps coagulating, so that the tumor can no longer be emptied by pressure, assuming the form of a broad, rounded, or indurated mass.

Internal Piles.—When the pile is situated altogether within the verge of the anus, it is called internal; of these there are two principal varieties, the *longitudinal* and the *globular*.

The *longitudinal*, or, as it is sometimes called, the *fleshy* pile, is generally met with about an inch or two up the rectum. It is spongy, elastic, firm, or tough, of a dark reddish, or dusky brown tint, tapering upwards from a broad base. It seldom bleeds or varies much in size; between the piles are found small curtains, valves, or folds of mucous membrane, forming sacculi or pouches, with their convexities looking upwards. These sacculi are apt to become distended and pressed downwards by the feces, especially if the motions be hard and the bowels have been constipated, thus giving rise to a tendency to prolapsus.

When the hæmorrhoid assumes a *globular* form, it constitutes the ordinary bleeding pile. It may be situated on a broad base; or, as not unfrequently happens, its point of attachment to the mucous membrane becoming elongated, it assumes a pedunculated shape, hanging downwards into the cavity of the rectum. It is of a dark bluish color, and numerous small vessels of a brighter hue than the body of the pile may be seen ramifying on the mucous membrane investing it. Its surface is at first smooth and shining, and may continue so throughout, being covered with a thin and delicate prolongation of the lining membrane of the gut. Not unfrequently, however, superficial ulceration takes place, and then it has a granulated strawberry-like appearance.

Symptoms.—Internal piles are usually attended by a sensation of heat, itching, pricking or smarting about the anus, and a feeling as if there were a foreign body within the gut. After defecation these sensations are increased, and are often accompanied by a bearing down, as if the bowel were not emptied of its contents, that is peculiarly distressing and sickening. This is occasioned by the piles, or the elongated

and condensed mucous membrane to which they are attached, being protruded during the expulsion of the feces, and not returning sufficiently quickly, being grasped by the sphincter ani and constricted by it. This feeling of discomfort and bearing down is much increased, if the patient stand or walk much after having had a stool, or if he have a confined state of the bowels. If this state of things be not properly attended to, the symptoms become increased in severity; the bearing down sensation amounts to true tenesmus, and the act of defecation becomes so painful that the patient defers it as long as possible, and then, when it does take place, in consequence of the accumulation of the excreta and their indurated character, the suffering is much increased. Internal piles now usually make their appearance, if they have not existed before; the mucous membrane of the rectum becomes prolapsed, and an increased secretion of thin mucus takes place from the orifice of the gut, moistening the part and soiling the patient's linen. Irritation in the neighboring organs is frequently set up; occasionally to so great an extent as to mask the original complaint, the patient referring his principal pain and discomfort to these sympathetic disturbances. There is often a dull aching fixed pain at the lower part of the lumbar spine, and more frequently opposite the sacrum or the sacro-iliac articulation on either side; this is sometimes very severe, perhaps down the thigh, or round the groins; irritability of the testicles may come on, or irritation about the neck of the bladder, causing frequent desire to micturate, and increasing the patient's sufferings by the straining that takes place. The general health now suffers, the patient may become emaciated, and the countenance often presents a peculiarly anxious, drawn, and careworn look.

The symptom, however, that first of all and most prominently fixes the patient's attention, is *hemorrhage*. This varies greatly in quantity; at first there may merely be a few drops falling after the passage of a motion, or the cylinder of feces may be stained on one side by a streak or spots of blood, or the bleeding may amount to several ounces or even pints. When moderate in quantity, it often affords relief to the other local symptoms, and seldom proves injurious from the quantity lost at one time; but, if profuse, and occurring at short intervals, its effects on the constitution may be alarming.

The hæmorrhoidal flux is connected with, and in the great majority of cases dependent upon, the existence of distinct hæmorrhoidal tumors. Occasionally, however, it appears to occur when there is no distinct separate tumor projecting above the surface of the membrane; but in these cases there is general intumescence and congestion of the whole of the mucous membrane of the lower part of the rectum, from which the blood exudes in drops, or it may even spirt in a distinct jet from the open mouth of a bloodvessel.

It is frequently ushered in by an exacerbation of those symptoms that commonly accompany piles, such as a sensation of fulness, weight, and tension, about the parts. But the symptoms that precede its occurrence are often much more imperfectly marked than is usually stated, and are frequently absent altogether.

The discharge of blood may be periodical, occurring every month, or at intervals of two, three, or six months; and it may be remittent or intermittent. When once it has set in, it usually continues from three to six days, increasing in quantity up to the third or fourth day, and then lessening.

When moderate in quantity and short in duration, it is often a source of relief to the patient; but if a very large quantity be lost at one time, or if it continue for too long a period, it becomes a source of great debility; more harm is usually done to the patient by its long continuance, than by its excessive quantity at any one time. The patient may become much debilitated and anæmic; nervous headaches, pallor, palpitations, and syncope may result. In some cases this discharge is of service, acting as a derivative, and preventing disease from falling on more important parts; it has especially been looked upon as, and doubtless is in many cases, a safeguard from apoplexy and visceral congestions and obstructions, particularly when it occurs in plethoric and corpulent persons who habitually live too highly. In other cases it may be considered as critical; especially when it occurs about the cessation of the menstrual period. But, as a rule, the continued loss of blood from piles is undoubtedly injurious to the patient's constitution.

Hemorrhage from piles is sometimes vicarious with, and at others arrests, the menstrual flow. In a case which I attended with Garrod, the patient had suffered from the hæmorrhoidal flux and piles from the age of puberty. She menstruated

for the first time when thirty-seven years old; up to that period the hæmorrhoidal discharge had occurred abundantly at monthly intervals. After the late establishment of the menstrual function, the piles continued to bleed, but less regularly, and she became anæmic, emaciated, and debilitated to the last degree. When she was forty-four years of age, I saw her for the first time; the piles, which were very large and vascular, were ligatured, and she made a most perfect recovery in general health.

The color of the blood is most generally florid, as if it came from the small arteries or capillaries of the part rather than from the veins. It would appear that, in consequence of the over-distended and varicose condition of the veins of the part, the onward flow through the arteries and capillaries leading to them is obstructed; and that, in consequence of the accumulated pressure on these vessels, their parietes give way, allowing the florid blood to escape from the arteries.

Very commonly the internal piles, when brought down, present a somewhat granular surface, in consequence of ulceration having taken place, and the whole surface will be seen to exude blood in drops. In other instances, the blood appears to come from a cavity in one side of the hæmorrhoid, as if rupture had occurred from over-distension at the part. Occasionally, however, the flow of blood is so rapid and copious that it cannot be supposed to come from exudation, but would appear to depend on rupture of the vessels of the part.

The hæmorrhoidal flux may be accompanied by, or alternate with, a thin glairy mucous discharge from the rectum and diseased structures; this would appear to be nothing more than excessive secretion from the membrane, in consequence of the irritation set up by the presence of the piles; it is seldom in sufficient quantity to produce much annoyance, or to be of much moment to the patient.

Complications.—Piles are not uncommonly complicated with other diseases of the rectum, such as fissures, fistula, or prolapsus. When connected with fissure, the hæmorrhoid often, as Syme has remarked, assumes a peculiar form and appearance, presenting itself as a small red-colored body, like a pea in size, firm, and seated at the base of the fissure, which it often conceals; to a practised eye, however, the presence of a pile of this peculiar color and shape is sufficient to indicate the existence of the fissure.

In that form of fistula in which the aperture is near the anus, one or more external piles of small size are often found situated at the orifice of the fistula; and prolapsus rarely, if ever, is met with in adults, without the simultaneous occurrence of piles.

Terminations.—Hæmorrhoidal tumors may terminate by subsidence, coagulation, suppuration, or sphacelus.

Subsidence.—Complete subsidence of the pile can only take place when the disease is of recent occurrence. When of long standing, and after it has been exposed to successive attacks of inflammation and turgescence, it never subsides completely; and the areolar tissue and the muco-cutaneous structures, becoming hypertrophied, form elongated pendulous flaps around the margin of the anus.

Coagulation of the contents of the pile is the result of inflammation having taken place in it, and probably terminating in plastic effusion, by which the vessels leading from it are obstructed. When it takes place, the tumor, after more or less active inflammation, becomes hard, incompressible, and indolent, permanent in size, and of a purplish or plum-color. The coagulum thus formed may remain persistent, may excite suppuration, or may be absorbed, the hypertrophied tissues forming one of the usual anal folds. In some rare instances, the coagula may become converted into structures resembling phlebolites.

Coagulation more frequently takes place in external than in internal piles, owing to the great impediment to the return of the blood from them, and to their greater liability to inflammation, their exposed situation leading them to be bruised or otherwise injured. When it occurs in internal piles, it most commonly affects those that are of a columnar or longitudinal shape, and least frequently the globular variety.

Suppuration is not an uncommon termination, if acute inflammation have been set up in external piles, more especially in those that have previously been coagulated. When the abscess is discharged, small coagula escape with its contents, the cavity granulates and becomes obliterated, and the pile is cured.

Sphacelus.—In some cases, when there is much elongation of the mucous membrane from which the pile springs, prolapsus of that membrane and of the piles may

take place; and this, being grasped after it has descended, by the contraction of the sphincter, the same effect may be produced as if a ligature were applied. The tumor becomes much swollen, hard, livid, and tense; there are much constitutional disturbance and restlessness; but after a few days all the symptoms are relieved by the part that is constricted sloughing and dropping off.

Diagnosis.—The diagnosis must be regarded in two points of view: 1, as concerns the *hæmorrhoidal tumors;* and 2, with reference to the *hæmorrhoidal flux.*

1. *Hæmorrhoidal tumors* must be diagnosed from prolapsus ani, polypus of the rectum, and condylomata about the anus. From *prolapsus* the diagnosis is not always easy; indeed, the two diseases are so generally associated, that it is of little moment to attempt it. In true prolapsus, ocular examination will suffice to distinguish the membranous wall of the intestine, forming a smooth, rounded, and somewhat lobulated annular protuberance, from the isolated tumors of piles. In *polypus*, the history of the case, the pedunculated and solitary character of the tumor, its large size, and comparatively slight tendency to periodical hemorrhage, will enable the surgeon, to make the diagnosis. From *condylomata* the diagnosis is easy; the soft, flat, mucous, and wart-like character of these growths, their history, and their occurrence at other points, as the perineum, scrotum, vulva, and buttocks, will enable the surgeon to distinguish them without any difficulty.

2. The *hæmorrhoidal flux* must be distinguished from other *intestinal hemorrhages.* This may be done by attention to the character of the blood, which will enable us in many cases to determine its source. When it comes from piles it is liquid, of a more or less florid color; and not unfrequently is quite bright, staining or coating the feces rather than being mixed up with them. When, on the contrary, the blood is poured out at some higher point in the intestinal canal than the usual seat of hæmorrhoids, it is of a dark sooty character, mixed up with liquid feces either in a diffused form, or in small black coagula, and no fresh or bright blood will be visible. Digital exploration of the rectum in cases of piles, and the presence of symptoms indicating the existence of mischief at a higher part of the intestine than the anus in cases of melæna, will also serve to point to the seat of the flux.

Treatment.—In conducting the treatment of a case of piles, that surgeon will succeed best who looks upon the disease not as a local affection, merely requiring manual interference, but as a symptom, or rather an effect, of remote visceral obstruction and disease, the removal of which may alone be sufficient to accomplish the cure, without the necessity of any local interference; or, should it be thought necessary to have recourse to operative procedure, this must be made secondary to the removal of those conditions that have primarily occasioned the congestion and dilatation of the hæmorrhoidal vessels. The treatment of piles, therefore, must be considered, 1, as regards the removal of these constitutional conditions or visceral obstructions that occasion the disease, together with any topical applications that may be considered necessary; and, 2, with reference to the operative procedures that may be required for the removal of the affection.

1. The *constitutional management* of piles necessarily varies considerably, according to the condition of the patient in whom they occur, and the visceral obstruction to which they may be referable. Thus, when they occur in debilitated persons, apparently from relaxation of the vessels, most benefit will be derived from a mild tonic and nutritious plan, at the same time that the bowels are kept regular by some of the aperients that will immediately be mentioned. In these cases, also, much advantage is often obtained by the administration of the confection of black pepper, which acts as a useful local stimulant to the vessels of the rectum. In the great majority of instances, however, more particularly when occurring about the middle period of life, piles are connected with a plethoric state of system, and obstruction of the abdominal viscera. In these circumstances, our efforts should be directed to the reduction of the plethoric condition, by putting the patient upon a proper regimen, prohibiting the use of stimulants, and lessening the quantity of animal food that he is in the habit of taking. When piles arise from the pressure of a gravid uterus or other abdominal tumor, little can be done; except, by local palliatives and mild aperients, to moderate the inconvenience attending them.

In all cases of piles, but more particularly in those arising from hepatic obstruction, mild aperients are of essential service; by removing feculent accumulations, and establishing a free secretion from the intestinal surface, they tend materially to prevent congestion of the portal system. At the same time, drastic purgatives of

twice or thrice a week at bedtime, in as small a quantity as will be sufficient to keep the bowels free. In many cases the confection of senna may advantageously be given in combination with precipitated sulphur and the bitartrate of potass, equal parts of each of these being made into a mass with twice their quantity of the confection and a little syrup; of this electuary a dessert-spoonful may be taken every night or every second night. If there be a relaxed condition of the rectum and anus conjoined with the piles, as not unfrequently happens in old as well as in young people, the administration of an electuary composed of equal parts of the confections of senna and of black pepper, or of cubebs, will be found very useful. In fact, in all cases in which the black pepper is administered, an aperient should be given from time to time, to prevent its accumulation in the large intestine. When the liver is much obstructed, the treatment should be specially directed to the relief of this organ; with this view, a course of Plummer's pill, followed by taraxacum, and, in relaxed constitutions, the mineral acids, will be found especially serviceable, at the same time that the bowels are kept free by gentle aperients.

[Great benefit may be sometimes derived from the habitual use of Saratoga water in moderate quantities.—A.]

The habitual use of lavements, consisting either of soap and water or thin gruel, will be found advantageous in many case of piles, though in some they appear to irritate, and rather to increase the disease. When the piles occur in relaxed constitutions, the lavement should be used cold; but when the patient is of full habit of body, a tepid one will usually be found to agree best. In the general management of piles it need scarcely be observed that any habits which favor the disease should be sedulously avoided.

The *local treatment* of piles is of considerable importance. The parts should be regularly sponged with cold water, morning and evening. If there be much relaxation, and the piles be internal, benefit may result from the employment of some astringent injection, such as a very weak solution of the sulphate of iron, or of the tincture of the sesquichloride—a grain of the first or ten drops of the second, to an ounce of water; of this about two ounces may be injected every night and left in the rectum. The application of an astringent ointment, such as the unguentum gallæ compositum, or the employment of the anodyne and astringent suppository already recommended, will be attended with much benefit.

If the piles become inflamed, the patient should keep his bed, and leeches should be freely applied around but not upon the tumors. Tepid lotions, poultices, and poppy fomentations, must be assiduously used, a very spare diet enjoined, and the bowels opened by mild saline aperients. If a coagulum form in an external pile, as the result of inflammation, the tumor should be laid open with a lancet, and its contents either squeezed, or turned out with the flat end of a director. If abscess form, it must be punctured in the usual way, and the part afterwards poulticed. Should strangulation of the piles take place, the protruded swelling must be returned by gentle steady pressure, and the part afterwards well poulticed.

[The local application of bladders filled with pounded ice is a most efficient and soothing application in cases of inflamed piles. For the intolerable itching which sometimes attends external piles, I know of no application so useful as the dilute citrine ointment, as recommended by Mr. Curling. The following formula will be found satisfactory: R. Unguent. hydrargyri nitratis ʒj; Unguent. aquæ ros. ʒvij. Misce. —A.]

2. *Operation.*—The means above indicated are usually sufficient in ordinary cases of piles; but if the disease attain an inconvenient size, giving rise to general irritation and local uneasiness, or if the abundance of the hemorrhage be such as seriously to interfere with the health of the patient, it will become necessary at last to have recourse to operative interference, with a view of removing the diseased structures. No operation should ever be undertaken whilst the pile is in an *inflamed* state, lest unhealthy inflammatory action to an undue extent be set up in *the part; it is also* well to get the patient's health into a good state, as erysipelas may otherwise follow the operation; and before proceeding to perform it, care should be taken that the bowels have been well opened.

There are three plans of treatment adopted by surgeons for the removal of piles; viz., the excision of the tumor, its strangulation by ligature, or destruction by caus-

tics. These methods of treatment should not be employed indiscriminately. The first is alone applicable to external piles; the last two may be adopted in the internal form of the disease.

Excision.—The removal of external piles is readily effected. The tumor should be seized with a vulsellum or hook, drawn forwards and snipped off with a pair of knife-edged scissors, curved upon the flat. At the same time when the external piles are removed in this way any pendulous flaps of skin in their vicinity should be excised, lest they become irritated, and constitute the basis of a fresh pile. After the excision of external piles, there is usually but trifling hemorrhage, which may readily be arrested by the application of cold lint, or a pad and T-bandage; should any small artery bleed, it may be pinched, and the hemorrhage thus stopped. The hemorrhage attendant on this little operation is sometimes rather profuse. This may be obviated by adopting the method introduced by H. Smith, which is as fol-

Fig. 505.

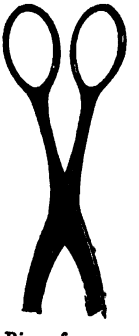
Smith's clamp.

lows. The pile is seized in a clamp (Fig. 505), drawn forwards, fixed by a few turns of the screw, and cut off. The cut surface is then seared with a cauterizing iron, by which hemorrhage is prevented and cicatrization facilitated.

Ligature.—Internal piles should be removed by the ligature only; in fact, it may be laid down as a rule in surgery, that all external piles should be cut off and all internal piles tied. The reason of this difference in the practice to be adopted, according as the pile is situated above or below the margin of the anus, is the liability to hemorrhage in the one case, but not in the other. The bleeding that follows the excision of an external pile is not only small in quantity, but may readily be arrested by cold or pressure. With internal piles, however, it is different; these tumors are not only more vascular, being often fed by a large central arterial twig, but are deeply seated, and do not readily admit of the application of means for the arrest of the flow of blood from them. So difficult is it to stop the bleeding from an internal pile in some cases, that patients have actually lost their lives from this cause after its excision, even in the hands of some of the most distinguished surgeons. The excision of internal piles has consequently been very properly abandoned.

The *operation for the ligature of internal piles* may most conveniently be conducted in the following manner. The patient, having had his bowels cleared out by a dose of castor oil on the day preceding that fixed for the operation, should have an abundant lavement of warm water administered about an hour before the surgeon arrives; and he should then be directed to sit for half an hour on a bidet, or over a pan containing hot water, bearing down at the same time, so as to cause the piles to protrude. When all is ready, he should be laid on the bed on his left side, with the nates well projecting; the surgeon then seizes the most prominent pile with a hook, vulsellum, or ring-forceps (Fig. 506), draws it well forwards, and ties its base as tightly as possible with a thin whipcord ligature. He does the same to one pile after the other, until all that can be met with have been strangulated in this way. In some cases the pile is so broad at the base, that the ligature will not include it without transfixion; when this is required, it may usually be done readily enough by means of a nævus-needle, or by the instrument represented in the annexed drawing (Fig. 507), Bushe's needle, which consists of a steel shank fixed in an ivory handle, and having its free end perforated for the reception of a needle-eye near its point. The advantage of this instrument is, that not only is the angle formed by the needle and the shank a very convenient one for passing a ligature through a pile inside the anus, but more particularly that, as the needle can be detached, it

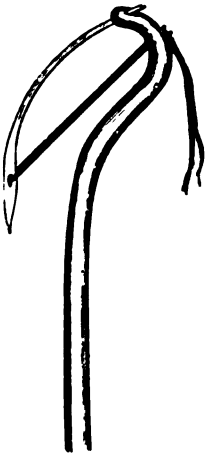
Fig. 506.



Ring forceps.

may as soon as it is carried across the base of the tumor, be separated and so withdrawn more readily than it otherwise could. If the pile be longitudinal, it may be deeply notched in a direction upwards at its lower attachment, and the ligature tied in the groove thus formed. In whatever way the ligatures are applied, care should be taken that they are tied as tightly as possible, so that the piles may be effectually strangled at once; as in this way they separate much more readily, and with far less pain to the patient than if loosely tied. When all the tumors requiring ligature have been tied, the ends of the threads must be cut off close, and the strangulated mass pushed back into the bowel. If there be any external piles, these must now be cut off; for, unless this be done, they become irritated, swollen, and inflamed by the presence of the ligatures, and constitute a source of much distress. The patient must now return to bed, and should keep the recumbent posture until the ligatures separate, which usually happens from the sixth to the eighth day, when an ulcerated surface will be left, which, however, speedily closes and contracts. In some cases this process may be facilitated by the application of the nitrate of silver through a speculum ani. On the second day after the operation the bowels may be opened with a dose of castor oil. In the after-treatment of the case, care must be taken to prevent the recurrence of those causes that gave rise to the affection in the first instance. After piles have been tied, more particularly if they be seated towards the anterior part of the rectum, there is frequently great irritation set up about the neck of the bladder, so that the patient experiences difficulty in passing his urine, and sometimes suffers from complete retention; a warm hip-bath, and a full dose of hyoscyamus and nitric ether, will usually relieve this, and enable the urine to pass. In some cases, when the external piles are very large and vascular, and the patient debilitated, the ordinary rule of cutting them off may advantageously be deviated from, and a combination of the treatment by excision and ligature be adopted. In such cases an incision may be made through the integuments merely, and then the piles tied in the course of the groove thus formed. By these means the pain and constitutional disturbance consequent on the inclusion of a portion of the integument in the ligature are avoided, at the same time that the risk of hemorrhage is not incurred.

Fig. 507.



Bushe's needle for applying ligature to piles.

The treatment of piles by ligature is not altogether devoid of danger in persons of broken constitution. I have more than once known death from pyæmia result in these cases.

[Tetanus was the cause of death in one case lately operated on at the Episcopal Hospital.—A.]

Caustics.—In certain kinds of internal piles, the application of nitric acid has been recommended by Houston of Dublin and H. Lee, and may certainly advantageously be adopted. It must not, however, be applied to the external or to the intero-external pile, as it will produce extreme irritation; nor can it be looked upon as a substitute for the ligature in internal piles generally. It is especially in the granular pile, having an ulcerated surface, that this mode of treatment is useful; as in these cases it appears, by destroying a portion of the mucous membrane, not only to cure the pile to which it is applied, but, by producing an ulcer, to give rise to a cicatrix, which by contracting, consolidates the parts in its vicinity, and so lessens the relaxed state of the rectum, which favors the hæmorrhoidal tendency. The acid may most conveniently be applied through a speculum ani, having an aperture on one side (Fig. 508). This should be introduced well oiled, until the pile project through the opening in it, when it must be freely rubbed with a piece of stick, or a glass rod or brush, dipped in the acid; the surface is then immediately wiped with a piece of lint saturated with prepared chalk and water, and the instrument removed. A thin slough separates, leaving a raw surface, which gradually cicatrizes and contracts. The application of the acid occasions but little pain when made fairly within the rectum; but if a drop of it accidentally come into contact

Fig. 508.

Speculum ani.

with the muco-cutaneous surface, a vast deal of irritation and inflammation is excited. This plan of treatment, though useful in particular forms of pile, as when the tumor is granular or flat, so as not to admit of ready removal by the ligature, should not be practised when the ligature can be employed, as it is by no means so certain a mode of treatment. It cannot be considered altogether devoid of risk; for I have known one instance in which fatal erysipelas followed the cauterization of piles with nitric acid.

[In cases of internal piles complicated with prolapsus ani, the *écraseur* may be used with advantage, more contraction following after the employment of this instrument than after the simple ligature.—A.]

Pruritus Ani is often an extremely troublesome affection, the itching and general irritation about the anus being almost unbearable. In many instances it appears to be a true prurigo of this part; in other cases it seems to be connected with the irritation of external piles, worms, or some similar affection. The *treatment* must in a great measure have reference to the cause. If there be an external pile, the removal of it, or if worms, their expulsion, will probably cure the disease. If it arise from prurigo, it will require some special treatment. In some cases the arsenical preparations will be found useful, together with the local application of chlorinated lotions, or those containing hydrocyanic acid.

[I have used a great variety of local applications in these cases, the most efficient perhaps being the preparations of tar, and the dilute citrine ointment already referred to.—A.]

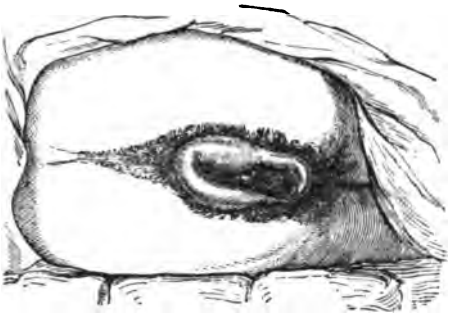
PROLAPSUS ANI.

Prolapsus ani consists in a protrusion of the mucous membrane of the rectum through the anal orifice; the cellular tissue that lies underneath it being also in the majority of instances much thickened and elongated. In the ordinary prolapsus, the muscular structures of the gut are not protruded; yet it has occasionally happened that the muscular coat has descended with the mucous membrane, an invagination of the bowel taking place, which constitutes a different and far more serious condition than the ordinary prolapsus.

Causes.—Prolapsus not unfrequently occurs in children, especially those who are feeble, or who suffer from much irritation of the digestive or urinary organs. In weakly persons generally there is a natural tendency to prolapsus; the slight protrusion of the mucous membrane which takes place during defecation being increased by any constitutional condition that gives rise to atony of the muscular system, especially if irritation of the intestinal mucous membrane be conjoined with this, as in dysentery, chronic diarrhœa, &c. So again, the habitual constipation often occurring in persons of a relaxed habit of body, apparently proceeding from want of power in the rectum to expel its contents, and requiring constant straining at stool, predisposes to this affection. It is especially common in those who labor under stricture, stone, or any other disease about the urinary organs that requires a considerable effort to be made in expelling the contents of the bladder. In persons whose constitution has been relaxed by a long residence in India, this disease also frequently occurs. In other cases, and indeed most usually, the prolapsus is associated with piles, the weight and dragging of the hæmorrhoid drawing down the mucous membrane with it. This is especially apt to happen, when there is general hæmorrhoidal tendency about the anus. In fact, the causes of prolapsus may be summed up under three heads: 1. Simple relaxation of tissue, such as is met with in children and weakly persons; 2. Sympathetic irritation, as in chronic tenesmus, stone in the bladder, &c.; 3. A hæmorrhoidal condition of the vessels of the part.

Diagnosis.—Prolapsus is readily recognized. It consists in the protrusion of a ring of mucous membrane of a red or purplish color, and having a somewhat turgid look, rather lobulated in shape, and varying in size from half a walnut to a small orange (Fig. 509). The mucous membrane covering this ring will be found to be continuous with that investing the sphincter, and this constitutes the mark of distinction between the ordinary prolapsus and the invagination that has occasionally been met with of the whole thickness of the gut; for in this affection, which is extremely rare, there is a deep and distinct sulcus between the protrusion and the margin of the sphincter. In prolapsus there is, when the protrusion is down, a

Fig. 509.



Prolapsus ani.

dragging and smarting sensation, often attended with a good deal of spasm about the neck of the bladder, and not unfrequently with symptoms of stricture. In chronic cases, the anal aperture will appear to be permanently relaxed; and, on introducing the finger into it, it will be found to be widened and weakened. The folds of skin in its neighborhood will be seen to be relaxed and elongated, radiating from it as from a centre; they are commonly bluish, soft, somewhat swollen, and pendulous, and often the seat of a good deal of irritation. The protrusion at first occurs only after defecation, and then readily goes back of itself, or is reduced by the exercise of steady pressure upon it; after a time, however, it will come down at other periods; thus it may protrude after riding, walking, or even standing, and is returned with much difficulty.

Strangulation of the prolapsus may occasionally occur, if it be allowed to protrude for a considerable length of time without a proper attempt being made to push it back. It then becomes swollen and livid, with great pain and tenesmus, discharges a fetid ill-conditioned pus, and may eventually fall into a sloughy state, and, thus separating, undergo a spontaneous cure.

Treatment.—The treatment of prolapsus may be said to be palliative and curative. The *palliative treatment* consists in the first place in reducing the tumor when protruded. This, under ordinary circumstances, the patient does for himself; but, if it become congested, it requires the help of the surgeon to put it back. This may occasionally be readily done by laying the patient on his side, or making him lean over the back of a chair; and then greasing the mass with some oil, seizing it with a soft towel, and, gradually compressing it, working it back. It may be kept up by the patient wearing a belt with a pad and elastic support. Olive-shaped pewter pessaries are occasionally employed, with the view of preventing the protrusion; but I have never seen them of any service, the sphincter being usually too relaxed to keep them up, and their pressure appearing to excite irritation.

The regulation of the bowels is as important in cases of prolapsus as in piles. It is usually best done by the administration of those laxatives that have been recommended for the latter disease. It is a good plan in prolapsus to get the patient to have his daily motion at bedtime instead of at the usual hour in the morning; the recumbent position and the uniform temperature of the bed preventing the irritation of the sphincter and spasm of the anal muscles that commonly continue for some time after the reduction of the prolapsus, and which are a source of great discomfort when occurring in the early part of the day.

[Advantage may be derived from requiring the patient to have his bowels moved while in the recumbent position, or even while standing, as the prolapsus is less likely to occur in either of these than in the ordinary sitting posture.—A.]

Curative treatment.—The relaxation of the mucous membrane of the rectum that essentially constitutes prolapsus may often be obviated by astringent injections or suppositories. The best injection is that of the sulphate of iron, in the strength of from one to three grains in an ounce of water, thrown up in small quantities sufficient for the bowel to retain. In children, injections of this kind, conjoined with regulation of the bowels by mild aperients, the administration of a moderate quantity of unstimulating food, and afterwards the employment of tonics, will commonly remove the disease, unless it arise from stone in the bladder, or some other affection inducing much and continued straining. In mild cases of prolapsus in adults, conjoined with a relaxed state of the mucous membrane of the rectum and relaxation of the sphincter, the use of the iron injection will be found particularly beneficial, at the same time that the action of the bowels is regulated by means of an electuary taken in the morning or at night. By thus giving tone to the bowel, at the same time that constipation is prevented, the disease will occasionally undergo a cure, provided it be not associated with any affection in other organs.

In those cases in which the prolapsus is hæmorrhoidal, the protrusion being dragged down by the weight and strain of the pile, the same treatment must be

adopted as has been recommended for the latter disease; and usually, after the ligature and removal of the pile, the prolapsus will be cured. In slight cases of prolapsus, in which the disease appears rather to be owing to the relaxation of the sphincter and of the tissues external to it, the muco-cutaneous integument hanging in loose and pendulous folds around the anus, considerable benefit will commonly result from snipping of these pendulous flaps of skin; the cut surface that is left cicatrizing, and by its contraction bracing up the part, and thus preventing its further protrusion. These pendulous flaps are best removed in a radiating manner from the anal orifice, with curved knife-edged scissors.

When the prolapsus is considerable, and if the ordinary palliative treatment have, after a proper trial, being given it, failed in effecting a cure, it will be necessary to remove the protruded mucous membrane by operation. This should always be done by the application of the ligature; excision, though easy, being objectionable in this as in the case of piles, on account of the danger from hemorrhage.

Application of ligature.—The patient having had the bowels freely opened on the preceding day, and an enema of tepid water on the morning of operation, should be directed to sit over a pan of hot water, in order to make the prolapsus descend; it may then be seized with a pair of broad-ended forceps, such as are represented in Fig. 506, and drawn well forwards. The base must next be firmly tied with a strong piece of whipcord, and a similar process repeated on the opposite side of the anus. Should there be any difficulty on account of the shape of the protrusion in ligaturing the base firmly, this may be obviated by transfixing it with a hæmorrhoidal needle, and tying it on each side. I think, however, that it is better, if possible, to avoid doing this. The ends of the ligature must then be cut short, the whole protrusion returned into the bowel, the external flaps of skin cut off, and an opiate pill administered, so as to arrest all peristaltic action for a few days. Should the ulcerated surface show any difficulty in healing, it must be touched with the nitrate of silver. This operation always leaves a permanent cure.

The ligature of prolapsus, like that of *internal* piles, is not very painful, and for it chloroform need not be administered; indeed, it is, perhaps, better that it should not be given in these cases, as the protrusion is apt to slip up under its influence, the patient not being able to exercise the proper expulsive efforts. But, as the excision of the external flaps and piles is attended by very sharp suffering, it is as well to administer the anæsthetic at the time when they are being removed.

Should a prolapsus become strangulated, it would be necessary to try to reduce it through the sphincter by the employment of the taxis; if this cannot readily be accomplished, free incisions may be made into it; if it be not reduced, it will slough away, and thus undergo permanent cure. In some rare cases, a portion of invaginated intestine descending through the anus has become strangulated; in such cases as these, reduction must be effected; if possible without, but if necessary with, division of the sphincter.

DISEASES OF THE GENITO-URINARY ORGANS.

CHAPTER LXVII.

URINARY CALCULUS.

CALCULOUS DIATHESES AND DEPOSITS.

The urine is liable to the deposit of various solid matters, which, when amorphous and impalpable, are termed *sediments;* when crystalline, they constitute *gravel;* and when concrete, *calculus* or *stone.* These deposits, whatever form they may assume, are the result of constitutional causes; and these constitutional conditions giving rise to them are commonly called *diatheses.* Of these surgeons usually recognize

three: the *lithic*, the *oxalic*, and the *phosphatic;* besides these, however, others doubtless exist, the precise characters of which have yet to be determined.

Lithic Acid Diathesis.—This diathesis chiefly occurs in individuals of robust habit of body and florid appearance, who have lived high and suffer from irritable gastric dyspepsia. It is often associated with a gouty or rheumatic tendency, or with some of the more chronic forms of skin disease, especially psoriasis. It is characterized by scanty and acid high colored urine, which deposits on cooling two kinds of sediment, a yellow and a red. According to Lehmann, these sediments consist of urate of soda: but Golding Bird, and, I believe, most of the chemists in this country, regard them as lithate or urate of ammonia. The yellow sediment, containing an admixture of the coloring matter of the urine, is usually dependent on slight disorder of the digestive organs and skin, coming and going under the influence of very trivial causes. The red sediment, owing its color, according to Bird, to an admixture of purpurine, a highly carbonaceous ingredient, and indicative of imperfect assimilation, is met with in persons of full habit, who live too freely. A variety, or rather an admixture, of these sediments, constitutes the *lateritious deposit*, so common in gout and rheumatism. The red sand or gravel is a crystallized variety of the lithic acid sediment. It may be compared, in general appearance, to cayenne pepper, and under the microscope presents the characters seen in Fig. 511. It is not unfrequently met with in children of a strumous habit,

Fig. 510.

Lithic acid.

Fig. 511.

Lithate of ammonia.

who are allowed more animal food than they can well assimilate. Occasionally crystals of lithic acid are found intermixed with these deposits, presenting the characters figured in Fig. 510.

Calculi.—The calculi that occur in this diathesis are of two kinds; the lithic acid, and the lithate of ammonia. The lithic acid calculus (Fig. 512) is usually of small or moderate size, varying from a pin's head to a pigeon's egg; it is oval, somewhat compressed and flattened, smooth on the surface, and of a fawn color. On section it is seen to be laminated, and to present various shades of a light brown or fawn tint. The lithate of ammonia calculus is of very rare occurrence; when met with, it is chiefly in children, and is composed of concentric rings, having a fine earthy appearance, and being clay-colored.

Fig. 512.

Lithic acid calculus.

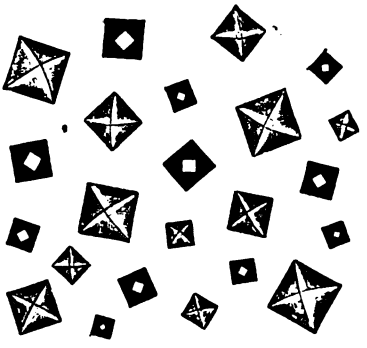
Treatment.—The treatment of the lithic acid diathesis must be directed to the removal of the prime causes of this condition, viz., mal-assimilation, defective oxygenation of the blood, and the ingestion of too large a quantity of stimulating food. All these may be remedied by attention to ordinary hygienic measures; the patient must live sparely, should avoid fermented liquors, especially red and effervescent wines, and abstain from sweets, pastry, &c. He should take plenty of out-door exercise, and keep the skin in healthy action by warm dry air or vapor bathing, and the use of horsehair gloves. The bowels must also be carefully regulated by means of saline and other aperients, with occasional alterative doses of Plummer's or blue pill; to which, if the constitution be peculiarly rheumatic or gouty, some colchicum may advantageously be added. A very good aperient for

general use in these cases, is a drachm of Rochelle salt in an ounce and a half of the compound decoction of aloes, taken at night or early in the morning; or a dessert-spoonful of the following powder every morning: ℞. Pulv. rhei, ʒss; Potassæ tartratis, ʒj; Magnesiæ ustæ, ʒij; Pulv. zingiberis, ʒj; fiat pulvis. The patient may also be directed to drink some of the natural alkaline waters, as those of Vichy or Fachingen. The Vichy waters, containing a large quantity of carbonate of soda, with free carbonic acid, are extremely serviceable for the correction of this diathesis. If they cannot be procured, a very good alkaline drink consists of a scruple of bicarbonate of potass and 5 grains of nitre dissolved in a tumbler of cold or tepid water, to which about 5 grains of citric acid, or a tablespoonful of lemon-juice may be added, and taken early in the morning, or in the middle of the day.

When lithic acid calculus has actually formed, it is well not to give the alkaline remedies too long, or in too large quantity; lest the stone rapidly increase in size by becoming incrusted with phosphates.

Oxalic Diathesis.—This is characterized by the formation of oxalate of lime in the urine. It generally occurs in individuals in whom there is defective assimilation, dependent upon exhausted nervous energy, arising from over-work, mental anxiety, or venereal excesses. The patient is usually pale and hypochondriacal, suffers from dyspepsia, acidity of stomach, and disturbed sleep. In these cases there is often loss of sexual power; a state of debility of the generative organs, connected either with the want of erectile vigor, or too speedy emissions. The urine is usually very pale, abundant, and acid, and there is heat and smarting during its passage along the urethra. In this diathesis there is no sediment or gravel, properly speaking, but the crystals float in the urine; subsiding, however, when it stands, but not occurring in sufficient quantity to constitute a true sediment (Fig. 513).

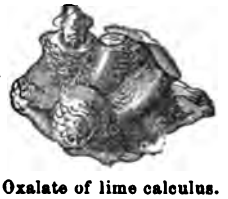
Fig. 513.



Oxalate of lime.

Calculus.—The oxalate of lime or mulberry calculus is usually of a dark-brown or almost black color, moderate in size, being seldom larger than a walnut, and round; it is always rough, tuberculated and sometimes almost spiculated on the surface (Fig. 514).

Fig. 514.



Oxalate of lime calculus.

Treatment.—When there is no calculus, it is necessary to put the patient upon a light and nourishing diet, especially fish, as recommended by Bird, cautioning him to avoid sweets and all fermented liquors, with the exception of a moderate quantity of brandy. Tonics, particularly the mineral acids, iron, zinc, and quinine may be given, and the residence should, if possible, be changed for a time to a warm climate. When calculus is formed, there is, owing to its roughness, and the irritable state of the patient's nervous system, usually a good deal of pain experienced in the region of the bladder; requiring the free administration of opiates.

Phosphatic Diathesis.—This chiefly occurs in old persons, or in those who are prematurely aged, with a broken constitution and an anæmic condition of the system. In this diathesis, the sediment and calculi may occur in three distinct forms: 1. Triple or ammoniaco-magnesian phosphate; 2. Phosphate of lime; and 3. Mixed phosphates, consisting of a mixture of the preceding varieties.

1. The *triple phosphate* (Fig. 515) usually occurs in urine that is copious, pale, and barely acid, sickly to the smell and soon decomposing and becoming very offensive. In other cases the urine is dark, alkaline, and mucous. This condition especially occurs in old people, and is associated with much debility, irritability of mind, pallor, and anæmia.

Fig. 515.

Ammoniaco-magnesian phosphate.

in some cases apparently produced by the mucous membrane of the bladder.

3. *Mixed phosphates* commonly occur after injuries of the spine, as the result of general impairment of the health, or in advanced cases of prostatic disease. They are occasionally met with in large quantity, forming a kind of mortar-like sediment in the bladder.

Calculi.—The phosphatic calculi are very common. The most frequent is the mixed, or fusible calculus, as it is termed, on account of the ready way in which it melts when exposed to heat. This calculus is friable, laminated, and has a chalky or earthy look. The calculus composed of phosphate of ammonia and magnesia is not so common; it resembles the preceding rather closely in its general characters, but is whiter and has a more chalky look. The phosphate of lime calculus is extremely rare; it is laminated, and harder than the other varieties.

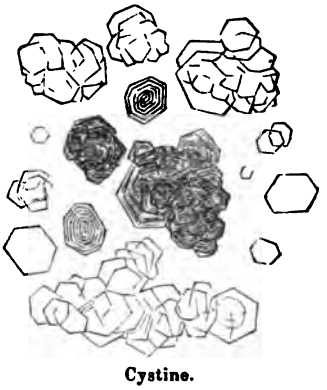
Treatment.—The treatment of the phosphatic diathesis consists principally in improving the digestive powers, and in restoring the general strength of the patient by giving him good food, wine, or beer. The administration of tonics, especially of nitric acid, should be attended to, and exercise in the open air enjoined. As there are usually much pain and irritability of system in this diathesis, opium may advantageously be administered.

Besides the calculi mentioned, various other kinds of concretions form in the urine, each of which doubtless represents a diathesis; the characters of which, however, are not so distinctly marked or so well recognized as those that have just been described.

Xanthine, or **Xanthic Oxide**, was first noticed by Marcet, and has since been observed by Laugier, Langenbeck, and others. It is of extremely rare occurrence, and has only been found in three recorded instances in the form of calculous concretions. These have generally been of small size, with the exception of the one removed by Langenbeck, which weighed 388 grains. For a detailed account of the chemical characters and constituents of this substance, as well as of the other materials of which calculi are formed, I must refer to the works of G. Bird, Beale, Thudichum, &c.

Carbonate of Lime has occasionally been met with as an amorphous powder in alkaline or very faintly acid urine. I am not aware of any urinary calculus of this composition having ever been found; but Bird states that he has detected carbonate of lime as forming a distinct stratum in some phosphatic calculi; and Thudichum has examined prostatic concretions consisting almost entirely of this substance—the urinary origin of which, however, he doubts.

Fig. 516.



Cystine.

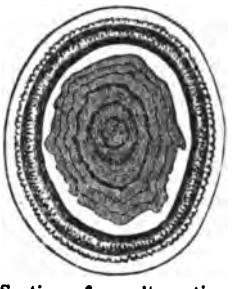
Cystine is one of the rarer forms of morbid product occasionally met with in the bladder. It differs from all other ingredients in containing a large quantity—about 26 per cent.—of sulphur. It is very rarely seen as a sediment in the urine; but when it occurs in this form it presents the microscopic characters seen in Fig. 516, being composed of hexagonal laminæ. Calculi containing cystine have occasionally been met with. Golding Bird states that in Guy's Hospital Museum there are eleven composed of this peculiar animal matter; and in the Museum of University College we have some good specimens. Cystine in calculus has a peculiar yellowish or greenish and waxy look, very different from any other ingredient met with in urinary concretions.

STONE IN THE BLADDER.

Structure of Calculi.—Calculi, though sometimes composed throughout of the same deposit, are not unfrequently made up of layers or strata, differing in chemical composition from one another, and these usually go by the name of *alternating calculi* (Fig. 517). Most frequently the nucleus consists of lithic acid; next in the order of frequency comes the oxalate of lime; and then the concretion of a phos-

phatic character throughout. It is very seldom that the nucleus is absent; but concretions have occasionally been met with in which none could be detected, or in which it was even replaced by a cavity. The nucleus is usually as nearly as possible in the centre of the calculus, and is generally pretty regular in shape; occasionally, however, it is branched or curiously radiated, and then the concretion generally affects a corresponding outline. Calculi containing two or three nuclei have sometimes been found, consisting probably of an equal number of concretions agglomerated together.

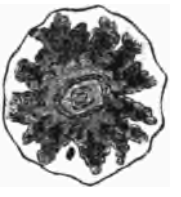
Fig. 517.



Section of an alternating calculus.

The body of a calculus having the uric acid nucleus is usually composed of some of the lithates; but not unfrequently these are incrusted by a deposit of phosphates. In other instances, the body may be wholly composed of some of the earthy phosphates, which more rarely alternate with the oxalate of lime or the triple phosphates.

Fig. 518.



Section of oxalate of lime calculus incrusted with phosphates.

An oxalate of lime nucleus usually has a body of the same constitution; but in some cases it is incrusted by phosphates or urates (Fig. 518). When the interior is phosphatic, the concretion is always of the same constitution.

The alternations in the composition of a calculus are due to varying conditions of the general health, and consequently of the character and constituents of the urine, and of the state of the lining membrane of the bladder. The uric acid and oxalate of lime nuclei and layers are undoubtedly due to constitutional causes. The phosphatic laminæ, whether interposed between the uric acid or incrusting the calculus, are probably chiefly dependent on vesical irritation, consequent on the presence in the bladder of the previously formed uric acid or oxalate of lime nucleus.

Origin.—Calculi may be formed either in the kidneys or in the bladder. Those that contain nuclei of the urates or oxalates are probably renal in their origin; whilst those that have a phosphatic nucleus are usually vesical from the first; renal nuclei of this composition being rarely met with.

All renal calculi—all those vesical calculi that have a renal origin, and some of those even that appear to be primarily formed in the bladder—have a constitutional source, arising from a morbid state of the urine, which probably in its turn depends upon mal-assimilation, the peculiar form of which determines the chemical composition of the stone. Those calculi that are formed by deposit from the urine upon and around some foreign body, as a pin or straw accidentally introduced into the bladder, and some soft phosphatic concretions that appear to be the result of an unhealthy state of its mucous membrane, may be looked upon as being local in their origin.

Calculi of Renal Origin.—When a stone forms in the pelvis of the kidney, it usually gives rise to pain in the loin. When of small size, it may descend into the bladder with but little suffering to the patient; but, if large enough to irritate the ureter and to pass with some difficulty, it then gives rise to a peculiar train of symptoms, which will immediately be described. In some cases the calculus attains a very large size, occupying the whole of the pelvis of the kidney, extending into the calices and ureter, and being moulded, as it were, to the shape of the parts amongst which it lies; it then gives rise, by its pressure, to absorption of the substance of the kidney, and occasions, by the magnitude that it attains, excessive pain and irritation in this region, the patient usually dying, worn out by constant suffering and by the irritation of incurable kidney-disease. In some instances, stone in this situation has given rise to abscess in and around the kidney, and has even been discharged through an aperture in the lumbar region.

Descent of a renal calculus.—In cases in which a renal calculus descends into the bladder, the patient is seized with pain in the loin that has been the seat of previous irritation. This pain is usually of the most agonizing character, extending into the cord and testis, and down the inside of the thigh of the affected side. There is retraction of the testicle, with constipation and vomiting; frequently accompanied by the passage of scanty, high-colored, and bloody urine, and great constitutional disturbance. This pain usually continues of a somewhat remittent character, until

hours, and perhaps some days, the patient should have full doses of opium administered, be put into a warm hip-bath, and have mustard poultices applied to the loin, or be cupped in this situation, if necessary; the bowels should also be thoroughly emptied by enemata. It is well to bear in mind, that a somewhat similar train of symptoms to that induced by the descent of the calculus, may be excited by some forms of irritation or flatulent distension of the cæcum and descending colon, which will require appropriate treatment.

Calculi of Vesical Origin.—Though vesical calculi often owe their origin to the descent of a stone from the kidney, yet it frequently happens that there is no evidence of their coming from such a source, but every appearance of their being deposited in the bladder; a nucleus being originally formed in this viscus by the aggregation of some sabulous matters, around and upon which fresh deposits take place, until a true calculus is formed. In some instances, vesical calculi have been found deposited upon and incrusting foreign bodies, accidentally introduced into the bladder, such as a piece of straw, a pin, a bit of bougie, &c.

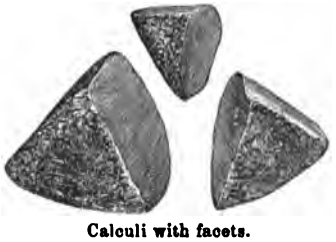
Number.—The number of calculi in the bladder varies considerably; most commonly only one is encountered; but in about one-fifth or one-sixth of the cases operated upon, several will be found; from two to six or eight are by no means uncommonly met with. Occasionally several dozens have been detected; and there are even instances on record in which some hundreds of distinct and separate calculi have been found in one bladder. The most remarkable case of this kind is one in which Physick removed from a judge in the United States upwards of a thousand calculi, varying in size from a partridge-shot to a bean, and each marked with a black spot. Several calculi may become matted together in one large concretion, as in the annexed representation of a calculus (Fig. 519) that I removed from a child four years old; it was formed of eleven distinct lithic acid calculi soldered together in this way; besides which, three others were lodged in the bladder. When two or more calculi occur, it is remarkable how uniform they are often in shape, size, and weight, one being the exact counterpart of the other.

Fig. 519.

Uric acid calculi matted together.

When there are several calculi in the bladder, the attrition of one against the other usually causes the opposing surfaces to become smooth, thus constituting "facets" (Fig. 520). In some cases, however, when the calculi are numerous, there are no signs of attrition. In a patient of mine who had fifteen calculi in his bladder, all the stones were round, about the size and shape of marbles, without any facets. In other cases, again, there may be more facets on one calculus than companion-calculi in the bladder. A second stone may occasion two or even three facets on the first, having rolled first to one and then to the other side of it.

Fig. 520.



Calculi with facets.

Spontaneous fracture of a calculus will sometimes occur within the bladder. This curious phenomenon may happen to a stone that is single, or to one among several calculi. When it occurs, great irritability of the bladder is set up. There are several ways of explaining this fracture, or rather disintegration, of a calculus. Civiale supposes it to occur by the contraction of the hypertrophied coats of the bladder upon the stone. It is possible that, when there are several calculi in the bladder, the concussion of one against another may give rise to it; and for the breaking up of a calculus to happen, it would by no means be necessary that this pressure of the bladder or concussion should be sufficiently strong to resolve the stone at once into fragments. If a crack or fissure merely be formed in it, the infiltration of the urine into this may so soften and loosen its cohesion, that it becomes resolved without further violence into a number of pieces. In some instances these become agglomerated together, by the deposit of a quantity of phosphatic matter upon and around them. In other cases, the

different fragments may each form the nucleus of a fresh calculus, so that the bladder may afterwards contain numerous concretions.

Physical Characters.—The *size* of calculi varies from that of a hempseed or pin's head to a concretion of immense magnitude. One of the largest with which I am acquainted, was a calculus removed by the high operation by Uytterhoeven, of Brussels, which I saw some time ago in his possession, and of which he has been obliging enough to give me a cast; it is of pyriform shape, and measures 19½ inches in its longest circumference, and 12½ inches round at its broadest part, being 6½ inches long, and about 4 wide. In the celebrated case of Sir W. Ogilvie, Cline attempted, but failed, to extract a calculus measuring 16 inches round one axis and 14 round the other. It weighed 44 ounces, and must have been of about the size of Uytterhoeven's. These enormous concretions are happily rarely met with at the present day; the usual size of stones removed by operation being from about one to two inches in the longest diameter, somewhat narrow, and perhaps flattened.

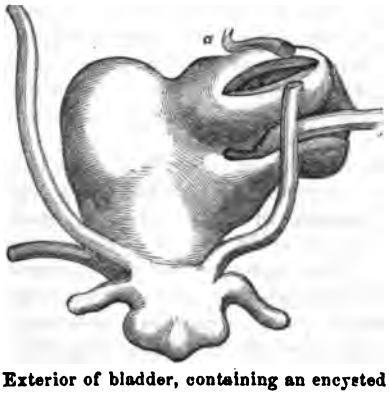
The *weight* of calculi commonly varies from a few grains to several ounces; the commonest size is from three drachms to about an ounce or two in weight, occasionally from three to six; from this they may range upwards until several pounds are reached. Thus, in Cline's case the stone weighed 44 ounces. Deschamps saw one of 51 ounces, and Morand one weighing 6 lbs.: none of these admitted of removal. The largest calculi are usually composed of phosphates, in greater part if not in whole. Large and heavy calculi are certainly less frequently met with now than formerly, owing to operations for stone being simpler and less dreaded since the introduction of anæsthetics, and hence practised in an earlier stage of the disease.

The *hardness* of calculi varies considerably; the oxalate of lime is the hardest; the lithates come next in consistence, and are often very hard, though brittle; the phosphatic calculi are always comparatively soft and friable.

The *shape* of calculi presents great variety; most commonly, however, they have an ovoid figure. Concretions of urate of ammonia and uric acid are generally pretty regularly ovoidal, smooth, and disk-like. Those composed of oxalate of lime are usually somewhat globular or square-shaped, and generally rough, nodulated, or spiculated upon the surface. The phosphatic calculi present usually the most irregular outline; most commonly, it is true, they are ovoid or globular, but are not unfrequently branched, as if moulded to the interior of the kidney, constricted, or of an hour-glass shape. The cystine calculi are generally tolerably oval and regular in outline.

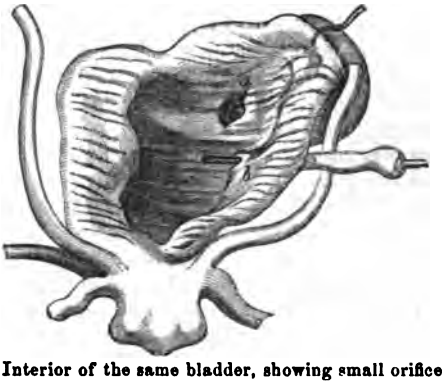
Position.—Most frequently calculi lie loose in the bladder; but occasionally they may be fixed, either by being encysted, and then lying in one of the sacculi that

Fig. 521.



Exterior of bladder, containing an encysted calculus at *a*.

Fig. 522.



Interior of the same bladder, showing small orifice leading into cyst at *a*: *b*, ureter.

have already been described within the walls of the bladder (Figs. 521 and 522); or by being fixed in and embraced by one of the ureters; and in other cases by being deposited upon, and partly included in, fungous growths.

Causes.—Whenever a foreign body of any kind, as a piece of broken catheter, &c., is introduced into the bladder, it will form the nucleus of a calculus, speedily becoming incrusted by calculous, probably phosphatic matter. But the causes of

calculi occurring spontaneously are very obscure. There can be little doubt, it is true, that the different forms of concretion are connected with the varieties of diathesis that have already been described; and we may look upon the formation of a calculus as the indication of the existence, in a greater degree of intensity than usual, of the causes which ordinarily give rise to sediments or gravel; but why, in particular cases, aggregation into a calculous mass takes place, it is impossible to say.

Age exercises considerable influence upon the production of calculi. Stone may occur in the bladder at all periods of life, and even, according to Stahl, may be congenital. The greatest number of cases occur during the first two decennial periods: thus Thompson, as the result of his statistical inquiries, states that one-third of the entire number of cases occurs before seven years of age, and one-half of the entire number before the thirteenth year is completed. Coulson has collected 2972 recorded cases of lithotomy from various sources; of these, 1466 occurred under the age of ten, 731 from eleven to twenty, 205 from twenty-one to thirty, 264 from thirty-one to fifty, and 306 from fifty-one and upwards. In many of these cases, although the patient was cut towards the middle period of life, the stone probably began to be formed during childhood.

Sex influences materially the occurrence of stone, which is far more frequent in the male than in the female, in the proportion of about twenty to one of cases requiring operation. This, however, does not represent the exact ratio; as owing to the shortness and large size of the urethra in females, many small calculi are voided by them that would be retained in the male.

It would appear that *in some parts of the world* calculus is a far more common disease than in others. It is generally more frequently met with in cold than in warm climates. The negro race is remarkably exempt from this affection. It is a singular fact that in some parts of the same country calculous disorders are of far more frequent occurrence than in others. Thus it is well known that the inhabitants of the east coast of England and Scotland are peculiarly liable to these disorders; and that in Norfolk stone occurs with especial frequency, this district furnishing, in all probability, as many cases as the half of the rest of England. In America also, it would appear that the inhabitants of certain States are peculiarly obnoxious to this affection; and I understand that in certain districts of Germany the disease may be said to be almost unknown, whilst in others it is of common occurrence. The relative frequency of the kinds of calculus also varies in different countries. Dr. H. V. Carter, who has analyzed and described upwards of a hundred specimens contained in the museum of the Grant Medical College, at Bombay, shows that the percentage of calculi with an uric acid or urate of ammonia nucleus is in India, 56.30, in England, 71.79; while that of calculi with a nucleus of oxalate of lime is in India 38.65, in England 16.87. The calculi composed purely of oxalate of lime also greatly exceed in number those which consist entirely of uric acid or urate of ammonia. To what these differences are owing, it is impossible to say. Peculiarity of race, of constitution, and of diet, with exposure to prevalent easterly winds, have all been assigned as reasons for them; but probably not on very sufficient grounds.

Symptoms.—The symptoms of stone in the bladder vary according as the calculus lies loose in the cavity of the viscus or is encysted. Their intensity will depend on the size and shape of the stone, the condition of the bladder, and the constitution of the patient. Most commonly, the severity of the symptoms is in proportion to the magnitude of the calculus. This, however, is not always the case. In a patient whom I once cut, the most intense suffering and repeated attacks of cystitis had been occasioned by a small but sharp-pointed calculus, not weighing more than a drachm; and some years ago I saw a patient in whose bladder five calculi were found after death, nearly as large as chestnuts, though their presence had never been suspected during life by the different surgeons under whose care he had been for stricture, so little distress had they occasioned. In some cases the symptoms of stone very suddenly declare themselves; and then the surgeon finds on examination that the patient has a largish calculus, which must have been a long time forming without attracting attention. Rough and angular calculi necessarily give rise to more severe symptoms than smooth ones, owing to their inducing a chronic form of cystitis; and as the constitution is usually a good deal shattered and the nervous system very irritable in those conditions of the system in which

the phosphates are deposited, phosphatic calculi are usually attended by more local suffering and constitutional disturbance than other forms of the disease.

The symptoms induced by stone are the result of the mechanical irritation produced by the presence of a foreign body in the bladder; they consist of pain, increased frequency in micturition, occasional stoppage of the urine, and various morbid conditions of that fluid.

The *pain* in calculus is often the first symptom that attracts attention; it varies greatly in character and degree. It may not only be experienced in the region of the bladder and the perineum, but may radiate widely in the course of the sacro-lumbar nerves, the patient complaining of a heavy and dragging sensation in the groins, extending down the outside or back of the thighs, and not uncommonly experienced even in the soles of the feet. The penis is the seat of a good deal of uneasiness; frequently of a sharp and cutting pain at the end of the glans. This is especially noticed in children, in whom attention is often attracted to the complaint by their constantly squeezing and pulling the organ to relieve the distress they suffer in it. The pain is much increased by any movement by which the stone is jolted about in the bladder, as in driving, riding, or jumping; and is especially severe in those cases in which cystitis occurs. It is always most severe towards the termination of, or immediately after micturition; as there is then a tendency for the calculus to roll forwards towards the neck of the bladder, where it comes into contact with and is grasped by the most sensitive part of that organ. Hence it is not unfrequent, in cases of calculus in children, to find that the little patient instinctively lies upon its back or side whilst passing urine, and thus escapes much of the agony that it would otherwise suffer. In adults in whom the prostate happens to be enlarged, the calculus usually lies in a depression behind this gland; and hence, being prevented from coming into contact with the neck of the bladder, occasions less suffering than in other cases.

In consequence of the irritation set up in the bladder occasioning chronic inflammatory action of the mucous membrane, there is an *increased frequency of micturition*. The urine is passed frequently, in small quantities at a time, usually contains some mucus or pus, and is occasionally tinged with blood, or loaded with thick vesical mucus. But in many cases the urine remains remarkably clear, transparent, and free from marked admixtures throughout. If the kidneys be irritated, the urine is commonly albuminous. The presence of blood in the urine is often one of the earliest signs of stone in the bladder, and in children especially should lead to the suspicion of the existence of calculus. It may be in large quantities, and may continue for many weeks, especially in the earlier stages. The urine may then clear as the bladder becomes accustomed to the presence of the stone, and the blood may only reappear under the influence of active movement, or of any cause of increased irritation of the organ. It very rarely happens that a stone has existed for any time, without the urine becoming occasionally streaked or tinged by blood.

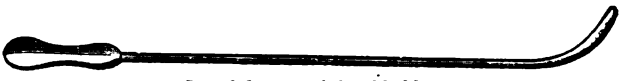
An occasional *stoppage in the flow of urine* before the bladder is emptied commonly occurs, owing to the stone being impelled against its neck, and thus blocking up the urethra; but, on the patient lying on his back or on his side, the stream flows again, the situation of the calculus being changed.

As a result of the straining and general irritation about the genito-urinary organs, *prolapsus of the anus*, accompanied by *tenesmus*, is by no means uncommon, especially in children; and in some cases there is very troublesome *priapism*.

When a stone is *encysted*, those symptoms that depend upon its being loose and rolling about in the bladder, are necessarily absent; thus there is no stoppage of the urine, this fluid is seldom bloody, and the pain is not materially increased by jolts and rough movements; though there are weight and pain in the usual situations, and increased frequency of micturition from the pressure and irritation of the calculus.

Physical Diagnosis of Stone.—The existence of stone is finally determined by *sounding the bladder*.

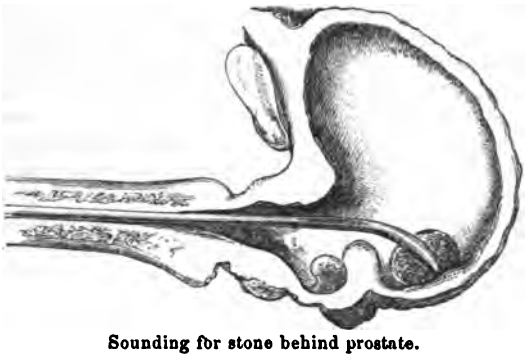
A *sound* is a solid steel instrument shaped like a catheter, but shorter in the curve (Fig. 523), so that it may explore thoroughly all parts of the bladder, especially those behind the prostate. It should have a wide and smooth steel handle and be slightly bulbous. The operation of sounding is conducted as follows. The patient lies upon his back on a hard mattress; a full-sized sound well oiled and warmed is



Sound for examining bladder.

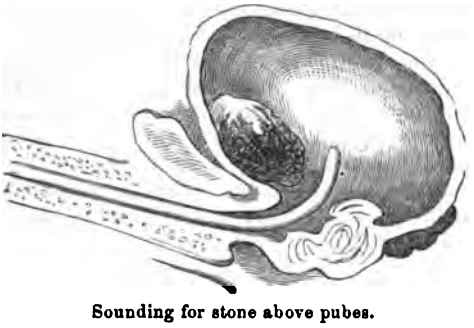
then passed into the bladder; which should, if the patient can retain it, be allowed to contain three or four ounces of urine. The surgeon then using his left hand, or crossing over to the patient's right side, whichever he finds most convenient, carefully directs the beak of the instrument towards the back of the bladder, turning it from right to left over the whole of that region, as shown in the adjoining cut (Fig. 524); he next draws it forwards on one side as far as the neck, tapping as it were gently with its beak; he repeats the same manœuvre on the other side; and, lastly, directs the end of the instrument by raising its handle into the lower fundus, which he carefully explores. Usually the stone is readily detected by these manœuvres, and its position in the bladder will often be dependent upon, and may to a certain extent be taken as an approximate indication, of its size. Thus, when moderately large it will usually be found lying to one side, most generally the right, of the neck of the bladder; when small, it will be placed towards the fundus, near the orifice of one or other ureter. These then are the situations in which the surgeon should first seek for a stone, and in which he will generally find it when present. Should it not be met with here, the chances are, more especially if the patient be elderly, that it will be found in a pouch behind the prostate, where it may be detected by raising the handle and so depressing the beak of the sound. Should the surgeon not detect the calculus in any of these situations, he depresses the handle between the thighs, and tilts up the beak so as to examine the pubic portion of the organ (Fig. 525). In the event of his not meeting with a stone, he may direct the patient to stand up, and then explore the bladder, first upon one side, then on the other. Should the rational symptoms of stone be well marked, though no calculus be struck, the surgeon must not give a decided opinion in the negative after the first exploration, but should examine the patient again a few days later, with the bladder in different states as to its contents. In making this second examination, I have found it of great service to use a hollow steel sound, by which the organ can be injected or emptied at pleasure (Fig. 526). The patient should on this occasion

Fig. 524.



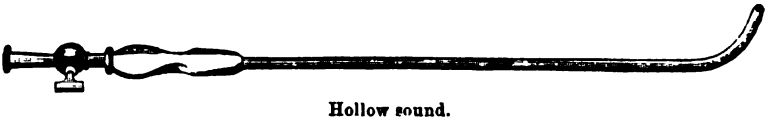
Sounding for stone behind prostate.

Fig. 525.



Sounding for stone above pubes.

Fig. 526.



Hollow sound.

have his bladder injected through such an instrument as this, with four or six ounces of tepid water, so as to distend the organ slightly, and prevent the folds of

any concretion that may exist in it. Its inte-
the way already described; and, if the stone
s of the bladder are gradually allowed to escape
s desired to stand up whilst the exploration is
, by examining a patient in different positions
ıdder as to capacity, a calculus is sure to be
may occasionally be advantageously used as a
uli lying behind the prostate, a situation more
an by an instrument of larger curve. These
too protracted; the time occupied should not
is be induced. When a stone is struck by the sound, there is not only a characteristic and distinct shock communicated to the instrument, but there is heard a tolerably loud click, which can be detected by the by-standers, and frequently by the patient as well as by the surgeon.

By conducting the sounding properly, the surgeon may usually ascertain not only the existence of a stone, but its size, and hardness; whether it be single, if it be encysted, and the general state of the bladder; with all of which it is of importance that he should be acquainted before undertaking any operation. A good deal of this information may be elicited by the ordinary sound, but some of the points can only be accurately determined by sounding with the lithotrite.

The *hardness* of the stone may usually be judged of by the more or less clear ringing character of the click; a lithic acid or oxalate of lime calculus giving a sharper sound than a phosphatic concretion.

A calculus may generally be known to be *encysted* if the sound strike it at times, but not at others (Fig. 527); if the stone always appear to be fixed in one situation;

Fig. 527.

Sounding for encysted calculus.

and if the beak of the instrument cannot be made to pass round it, so as to isolate it, but feel a kind of tumor projecting through the walls of the bladder, around or on one side of the point where the calculus is struck.

The fasciculated, roughened, and sacculated *condition of the bladder* may generally be detected by the way in which the beak of the instrument grates and rubs over the organ.

The *size* of the calculus is best determined by a lithotrite. It is true that a surgeon may sometimes come to a decision as to the bulk of a calculus, by observing the extent of surface along which the sound is in contact with the stone, as the instrument is being withdrawn. But a very rough guess only can be arrived at in this way; and I have frequently seen very experienced surgeons deceived in their estimate of the size of a calculus, mistaking perhaps several small ones lying together for one large one. By introducing a lithotrite and seizing the calculus gently between its blades, a correct estimate of its size may always be arrived at.

In order to determine that *several calculi* exist in the bladder, it is sometimes sufficient for the surgeon to feel that the beak of the sound comes into contact with a stone on each side of the organ, or that it can be distinctly insinuated between two concretions. In some cases, however, these points cannot clearly be made out; and then the surgeon, introducing a lithotrite and seizing the first calculus with which he meets, should hold this between the blades of the instrument, and whilst

it is so fixed move it and the lithotrite from side to side; when, if a click be heard and felt, he may be sure of the existence of another stone.

Errors in sounding occasionally occur. The surgeon may mistake a hardened and fasciculated bladder, having its ridges perhaps incrusted with sabulous matter, for a calculus; this is especially apt to happen in children. In these cases, however, the mistake may usually be guarded against by the absence of a distinct click, though a rough grating sensation be experienced, and by the surgeon being unable to isolate a stone. Yet the difficulty in some cases is great; Velpeau states that he is acquainted with four instances, and S. Cooper with seven, in which patients have been cut and no calculus found; and when we reflect that these accidents have happened to such men as Cheselden, who on three occasions cut a patient and found no stone; to Crosse, to Roux, and to Dupuytren, it is easy to understand that in some cases the difficulty of coming to a correct decision must be very great.

In *women* the symptoms of stone closely resemble those met with in men, and the detection of the calculus is usually very easy, owing to the shortness of the canal and the facility with which the stone may be tilted up by introducing the fingers of the left hand into the vagina. The sound used in these cases should be shorter and less curved than that employed for the detection of calculus in the male bladder.

Pathological Changes induced by Calculus.—After a stone has existed for some time in the bladder, it induces serious pathological changes in the whole of the urinary apparatus. The *urethra* usually becomes slightly dilated; and the *prostate* not unfrequently somewhat enlarged and irritable, in consequence of which a kind of pouch is formed behind it, in which the calculus is apt to lodge. The most important changes, however, take place in the bladder and kidneys. The *bladder* becomes extremely sensitive, especially about its neck, and is consequently unable to contain as much urine as usual; hence it becomes contracted. In some rare instances, however, as will be more especially noticed when we come to speak of lithotrity, it falls into an atonic condition, and then is apt to become rather largely dilated. The mucous membrane is commonly a good deal inflamed and irritated by the presence of the calculus; and the muscular coat becomes thickened and hypertrophied, so as to give it a very fasciculated or columnated appearance. Cysts occasionally form, containing sabulous matter and fetid pus or urine, and in some cases lodging a concretion, which then constitutes an encysted calculus lying altogether outside the cavity of the bladder, with which it merely communicates by a very narrow aperture, as in Figs. 521 and 522, representing a case that was under my care some years ago, and which is fully described in the Journals for March, 1853. The *kidneys* are usually irritated, often congested, frequently in a state of granular degeneration, and ultimately become the seat of such structural changes as are incompatible with life. When death occurs as the consequence of stone, the patient usually sinks, worn out by protracted suffering and kidney-disease.

LITHOTOMY.

It is not my intention to enter into the general history of lithotomy, an operation that has been practised from the earliest ages; nor to give a sketch of the gradual modifications that have at various times been introduced, from the rude attempts of the Greek and Roman surgeons to the barbarous and unscientific procedures adopted by the itinerant operators after the revival of letters. For all this, I would refer the reader to the classical works of Deschamps and of John Bell. The operation, as now generally practised in this country, is essentially that introduced by Cheselden, and modified more or less according to the views of particular surgeons. Though surgeons generally are agreed upon the great principles involved in it, they differ in carrying these out; as in the direction and extent of the incisions, and in the instruments employed, which have been much varied to suit the tastes and views of particular operators. But, although I look upon Cheselden's operation, as modified and practised by Liston, as being on the whole the simplest and safest mode of cutting for the stone as yet introduced, there can be no doubt that recourse may occasionally be had with advantage to other methods instead of it. Indeed, there is no operation that requires to be considered from so many and such different points of view as lithotomy. The size, shape, and position of the stone; the age and constitution of the patient, all render it desirable, and indeed necessary, to modify the method of operating. Hence, a surgeon should not be too exclusively

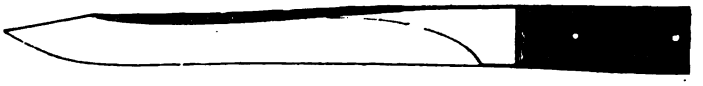
wedded to one plan, but should adopt one or other of the methods about to be described, according to the exigencies of the particular case before him.

Instruments.—The table for operating must be firm and of convenient height, so that when the surgeon sits on a rather low stool the patient's nates will be on a level with his breast; a few blankets doubled should be laid upon the table, and covered by a piece of tarpaulin hanging over the end; and a tray of sand placed under it on the floor. The instruments necessary are the following: a pair of lithotomy tapes, a sharp and probe-pointed scalpel, a staff, forceps, and scoops of various sizes, and a tube. To these may be added a searcher, and a brass injecting syringe.

The *tapes* should be of coarse flannel, about three yards long, by three inches broad.

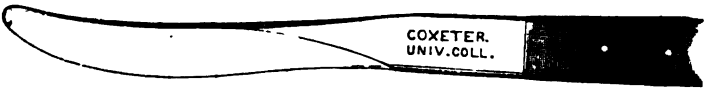
The *scalpel* for the adult may be of the size and the shape represented (Fig. 528); for children, it may be made proportionally small. A *probe-pointed lithotomy knife* of the size and shape here represented should also be at hand (Fig. 529).

Fig. 528.



Lithotomy scalpel.

Fig. 529.

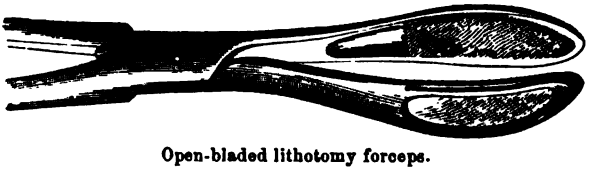


Probe-pointed lithotomy knife.

The *staff* should have a deep groove on its left side, occupying nearly one-third of the instrument; it should be well curved, of as large a size as the urethra will admit, and have a roughened handle (Fig. 535).

The *forceps* must not be too heavy, but should be of a good length in the handles, and have the joint well set back; the inside of the blades, as recommended by Liston, should be lined with linen to prevent the stone from slipping (Fig. 531). Coxeter has made them with open blades, but lined with linen as heretofore (Fig. 530); in this way, as there is less metal, the weight is diminished, and the diameter

Fig. 530.



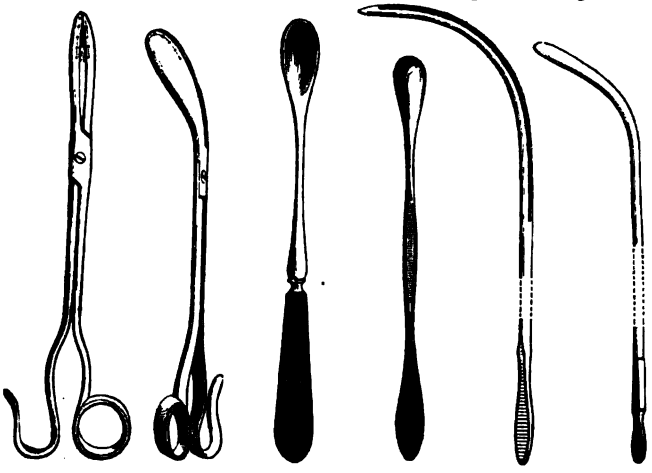
Open-bladed lithotomy forceps.

of the instrument with a stone in its grasp is materially lessened. The ordinary forceps are straight, but it is advantageous to be provided with some that are curved (Fig. 532). The handles should be made with a loop on one side and a ring on the other; the ring for the reception of the thumb should be placed somewhat obliquely. The *scoops* of different sizes, and curved, can most conveniently be used when fixed in a roughened handle (Figs. 533 and 534). The *tube* should be of gum-elastic, well rounded at the end, and provided with silver rings. The *searcher* is a slightly curved sound, having a bulbous extremity (Fig. 536). The *syringe* presents nothing peculiar.

[The nature and form of the instruments to be employed in lithotomy may be left very much to the fancy of the operator. Thus Prof. Gross of this city uses a very light and slender knife, sharp pointed, and with a blade three inches long and two lines wide; Prof. Pancoast prefers a scalpel with a concave back; while Prof. Smith operates with the cutting gorget. I am myself in the habit of employing an ordinary sharp pointed straight bistoury which I find sufficient for every stage of the

in the middle. Either form will be found satisfactory, provided that the groove is of an even depth to its termination, which should be about a quarter of an inch from the staff's beak. In using the common staff where the groove runs off into nothing, there is great risk of the knife slipping out and wounding the posterior wall of the bladder.—A.]

Fig. 531. Fig. 532. Fig. 533. Fig. 534. Fig. 535. Fig. 536.



Forceps. Curved forceps. Scoop in handle. Scoop. Staff. Searcher.

In describing the operation of lithotomy, we shall first of all consider *seriatim* the different steps of an operation that presents no unusual complication or difficulty; we shall then consider the difficulties that may be met with, and the accidents that may occur during the operation, and the principal sources of danger and the causes of death after its performance.

Preparation of the Patient.—Before subjecting a patient to operation, his general health must be properly attended to; and, indeed, if we find the constitution much broken by prolonged suffering, the bladder or kidneys seriously diseased, as indicated by the existence of pus or albumen in large quantity in his urine, it will be wise to postpone the operation for a time, or perhaps even to defer it altogether. There are few conditions in which a surgeon is placed, that test his moral courage more severely than the refusal to operate on a patient for stone, and thus allowing him to die unrelieved. For a surgeon to do this, unmoved by the entreaties of the patient and of his friends, requires no little self-reliance. Yet, when the patient is greatly emaciated, his constitution broken down, and his kidneys evidently disorganized extensively, lithotomy would be attended by an inevitably and rapidly fatal result, and the performance of an operation would be an useless act of cruelty. Supposing, however, that the stone is of moderate size, that the urine is either healthy or contains but a moderate quantity of pus or albumen, that there is no visceral complication to prevent the performance of the operation, and that the patient's health is in a tolerably good state, it will only be necessary to subject him to proper preparative treatment for a short time, so as to allay or remove irritability of the urinary organs before proceeding with it. With this view he should be kept as quiet as possible for about a week or ten days preceding the operation; his diet should be properly regulated, but not be of too low a kind; the pain should be lessened by the administration of opiates or henbane, and the bowels properly relieved. On the day preceding the operation, a dose of castor oil or some other aperient should be administered; and on the morning of the operation the rectum must be emptied by means of an enema.

Lateral Operation.—All the urine contained in the bladder having been drawn off, that organ should be filled by the injection of about six or eight ounces of tepid water, in order to steady it and to facilitate the seizure and extraction of the stone. After chloroform has been administered, the surgeon should introduce a full-sized

staff, which he uses as a sound, in order to feel for the calculus. If he detect it, he proceeds with the operation; if he cannot detect it, it is usually recommended that he should withdraw the staff and introduce a sound, with which he examines the bladder; and, in the event of his still failing to discover the presence of the stone, the operation must be deferred, for it is an imperative rule in surgery that lithotomy should never be performed unless the stone can be felt at the time when the patient is actually on the table. It is, however, safer not to proceed with the operation unlesss the stone can be felt with the staff; lest the point of this, though apparently in the bladder, be actually engaged in a false passage. The stone, then, having been felt, the patient is to be firmly tied up and brought to the end of the table, so that his nates project beyond it, where he is to be securely held on each side by an assistant, who grasps the foot in his hand, places the patient's knee under his arm, and draws the limbs well aside, so that the perineum may be fairly exposed. It is desirable that the perineum be thus fully exposed to the surgeon. In a patient, however, on whom I once operated, this could not be done, owing to the left hip being stiffened by chronic rheumatic arthritis; but I did not experience any particular difficulty in the operation, though somewhat inconvenienced by the position of the limb. The surgeon then, seating himself before the patient, shaves the perineum—if this have not already been done—and introduces his finger into the rectum to ascertain that the gut is empty. He then gives the staff into the charge of a trusty assistant, who stands on the patient's left, and who raises and draws aside the scrotum with the left hand whilst he holds the staff in the right (Fig. 537). The surgeon then sees that the staff is held in the way in which he prefers it. There are two ways in which it may be held; it may either be drawn well up into the arch of the pubes, or it may be pushed somewhat down, and slightly turned towards the left of the perineum. Liston always employed the first method, which I certainly think is the best, as it tends to increase the space between the urethra and the rectum, and consequently lessens the danger of wounding that gut, which more than counterbalances the advantage of the other method—that of approaching the membranous portion of the urethra to the surface.

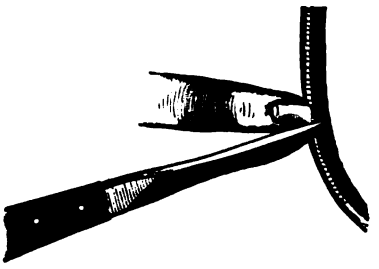
Fig. 537.

Position of patient and line of incision in lateral lithotomy.

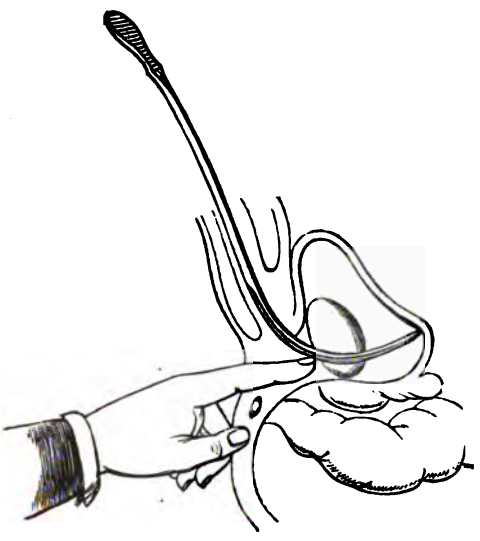
The external incision is made by entering the knife in the raphe of the perineum one inch and a half above the anus, and carrying it downwards and outwards, until it reaches a point that is just below the anus, but about one-third nearer to the tuberosity of the ischium than to the margin of the anal aperture (Fig. 537). It is useless to prolong the incision beyond this, as any freer division of the structures of the scrotum and on the nates cannot facilitate the extraction of the stone; but it must occupy the extent indicated, otherwise considerable difficulty may be experienced in the later steps of the operation. The depth to which this incision should be carried must vary according to the obesity of the subject; usually from about three-quarters of an inch to an inch, but not so deeply above as below. By this incision the skin, superficial fascia, and subcutaneous fat are divided. After it is completed, the knife is again introduced a little below the upper part of the wound, and the blade is run lightly downwards over any resisting structures; the left forefinger being placed at the middle of the wound, so as to protect the rectum. In this way the transversalis perinei muscle is divided, together with some areolar tissue and small vessels, and the triangular space is opened between the accelerator urinæ and erector penis muscles; the knife is then withdrawn, and the left index finger is pushed deeply into this space until the edge of the nail is lodged in the groove of the staff (Fig. 538), which can be felt just anterior to the prostate, thinly covered by the membranous portion of the urethra. The point of the knife is then pushed through the urethra at its membranous part into the groove of the staff,

and presses to the right the rectum lying beneath it (Figs. 539, 540).

Fig. 539.



Knife in groove of staff.

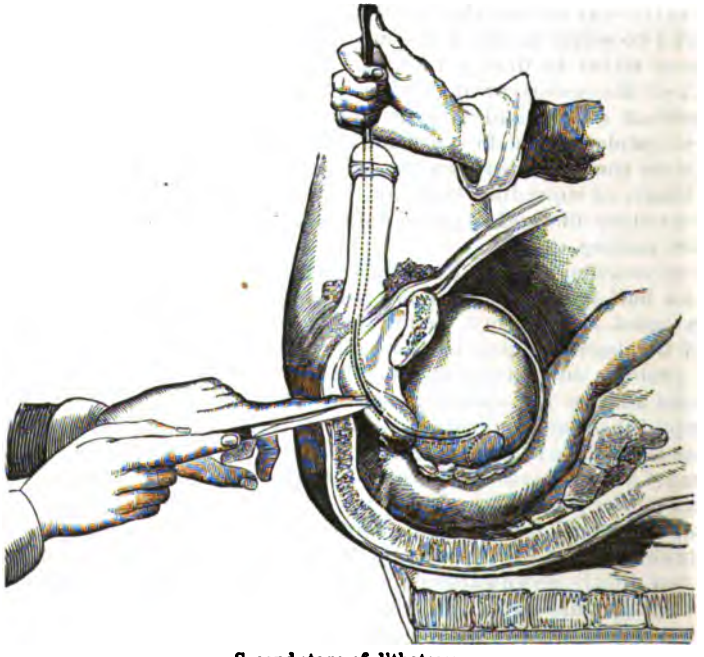


Lateral lithotomy: finger in groove of staff.

When the knife is felt to be well lodged in the groove, its handle is slightly depressed, so that the point may be raised; at the same time the blade should be somewhat lateralized so that its side lies parallel to the ramus of the ischium. If the edge be turned too directly downwards towards the mesial line, the rectum may be wounded; and if it be directed too much outwards, the internal pudic artery will be endangered (Fig. 541); hence the mid course is the proper one.

The surgeon, keeping the knife steadily in this position, and pressing the point firmly against the side of the groove of the staff, which he must never for a moment

Fig. 540.



Second stage of lithotomy.

lose, pushes it forwards through the deep perineal fascia, a few fibres of the levator ani, and the prostate, and thus makes an entry into the bladder (Fig. 540); he then withdraws the knife by keeping its back against the staff, so as not to enlarge the extent of the incision in the prostate. Through this, and along the staff, he then

pushes his left index-finger until it reaches the bladder, when he endeavors to feel the calculus with its tip. [The finger should be passed *above* the staff, between it and the pubis; there is thus no danger of entering the recto-vesical space.—A.] Should his finger be short, the perineum deep, or the prostate enlarged, he may be unable to reach the bladder in this way; and must then introduce a blunt gorget, as recommended by Cheselden and Martineau, in order to dilate the aperture in the prostate. If he use his finger for this purpose, he gives it a twist or two after passing it through the prostate, so as to expand and dilate the aperture through which it is entered. Having made sure that it is in the bladder, and having, if possible, felt the stone, he directs the assistant to withdraw the staff from the urethra.

Fig. 541.

Arteries of perineum and deep fascia.

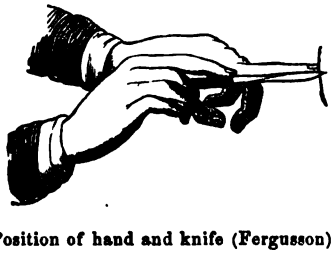
[Prof. Pancoast of this city makes his first incisions in the usual manner, but when the point of the knife is in the groove of the staff, takes the latter in his own left hand, and brings it down with a rapid sweeping motion while the knife enters the bladder; the point of the knife in this manœuvre not changing its position in relation to the staff.—A.]

Here let us pause, and examine the principal points in these the first and second stages of the operation. It will be observed that, in accordance with the best authorities upon this subject, and with my own experience, I have recommended the external incision to be free, the rectum to be protected by the left index-finger, the knife to be somewhat lateralized during and after the opening of the urethra, and the deep incision to be limited.

1. The *position of the knife* must be carefully attended to, especially during the deep or second incision. At this stage of the operation the edge should be *lateralized;* that is, directed about midway between the horizontal and perpendicular positions, so that the surface of the blade lies nearly parallel to the ramus of the ischium. The manner of holding the knife has been much discussed, and necessarily and naturally varies with different surgeons. I believe it signifies little how the handle of the instrument is held between the surgeon's fingers, provided the edge is never turned upwards, but is always kept well lateralized, and the point steadily pressed into the groove of the staff.

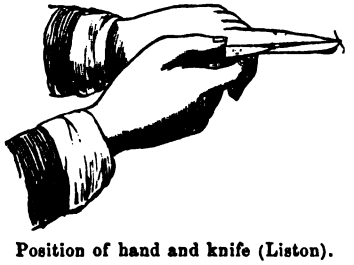
Provided a surgeon knows what he is about, he may safely hold his knife as best suits his own convenience. In the first incision, most operators, I believe, hold the knife *under* the hand, as represented in Fig. 542; a position which that excellent lithotomist and accomplished surgeon, Fergusson, preserves throughout the operation. Liston, in the early part of his career, appears to have held the knife, in the second stage of the operation, *above* the hand; and in all the representations, pub-

Fig. 542.



Position of hand and knife (Fergusson).

Fig. 543.



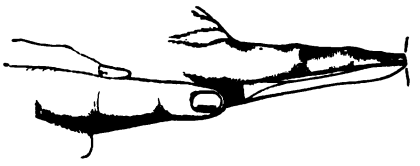
Position of hand and knife (Liston).

lished as well as unpublished, that he has left of his operation, he has depicted the knife and hands in the position shown in Fig. 543; which, in the last edition of his *Practical Surgery*, he describes as a correct sketch of "the position of the hands and knife" at the commencement of the second stage of the operation. There can

after his first few years as an operator, he held the knife under the hand, with the index-finger upon the side or the back of the blade.

For my own part, I believe that every surgeon will hold the knife in the way which he finds most convenient, and, as it were, natural to him. If any rules can be laid down on this point, I should say that, in operating on a child, or on an adult with a shallow perineum, the knife is most conveniently held as represented in Fig. 542. But if the patient be fat, and the perineum deep, then I think that it is a question whether greater steadiness may not sometimes be secured by holding the knife somewhat in the manner of a gorget, with the index-finger, perhaps, a little more upon the side of the handle (Figs. 540 and 544); in this way the point is firmly pressed into the groove of the staff, out of which it cannot slip, as it is secured and supported by the index-finger being somewhat under it. The section of the prostate is thus made by a steady push or thrust of the knife forwards, and not by any cutting movement downwards. No danger can result in the deep incision from pushing the point of the knife up into the groove of the staff; but there is great danger of missing the bladder, and entering the recto-vesical space, if it be at all depressed and the handle raised, though this cannot always be avoided if the staff be pushed deeply into the bladder.

Fig. 544.



Position of hand and knife (Author).

2. The *incision into the prostate* in the adult should be of very limited extent: on this point, I believe, all surgeons of the present day are agreed. Scarpa advises that the incision into it should not exceed five lines in adults, and two in children. It is difficult to measure the extent of the incision: it is sufficient to say, that it should be as limited as possible; and if care be taken to push the knife in, with the point well pressed against the groove, and the blade forming but a limited angle with the shaft of the staff, and especially in withdrawing it that it be brought carefully back over the finger and still in contact with the instrument, there will be no danger in cutting too widely, or in doing more than merely notching the apex of the prostate (Fig. 545, *a*). The danger, however, it must be borne in mind, does not consist in the section of the prostate itself—which is in reality a structure of but little importance—but in cutting beyond it into the reflections of the pelvic fasciæ, which will be opened up if the base of the prostate be cut, and the wound of which will, almost to a certainty, be followed by urinary infiltration and diffuse inflammation.

Fig. 545.

Incision in prostate.

In the section of the prostate, then, two points have specially to be attended to: one is, that the knife in entering be not pushed forwards at too great an angle with the staff, so as to cut widely; and the other is, that in its withdrawal the blade be kept steadily in contact with the staff. Indeed, I believe that there is more danger of doing mischief in the withdrawal than in the entry of the knife; for, if it leave the staff for a moment, all guide is lost, and the edge may sweep downwards through the base of the prostate and its investing capsule. As the knife is withdrawn, the left index-finger is pushed forwards into the aperture in the prostate, which is then dilated by its pressure to a sufficient extent for the introduction of the forceps, which are slipped in as the finger is withdrawn, and for the extraction of the stone. This part of the operation may very conveniently be performed, as was usually done by Liston, at the moment when the surgeon is stooping down, engaged in selecting his forceps. The dilatation of the prostate is readily effected; for this structure though

presence of the stone, all further proceedings must be deferr
cunity. The stone may escape detection in three ways. 1. It
e operation. A small calculus, especially if elongated and spindle-shaped,
passed by the urethra between the first examination and the time
give a very distinct click against the sound, and yet be not too large to pass thro
the urethra. 2. The stone may have become encysted. 3. It may have bee
enveloped in folds of the mucous membrane of the collapsed bladder, and so
escape contact with the sound. All these events are more likely to happen in
dren than in the adult, and it is in them that, for want of attention to these
cautions, the unfortunate accident of cutting into the bladder and finding no st
has most frequently occurred.

2. *Difficulty in entering the bladder.*—This is rarely experienced in adults.
may, however, arise in consequence of the surgeon neglecting to keep the point
the knife well lodged in the groove of the staff, and thus letting it slip into the rec
vesical space; the tissue of which, being broken up, leaves a kind of cavity that
mistakes for the interior of the bladder. If the perineum be very deep and
prostate enlarged, he may also experience some difficulty in reaching the bladde
but he can scarcely fail to do so if he push the knife well on in the groove of
staff, and dilate the incision in the prostate with a blunt gorget, if his finger fail
reach the cavity beyond it.

In *children*, however, great and sometimes insuperable difficulty has been e
perienced in opening the bladder. This difficulty arises in consequence of the sm
size of the urethra, the mobility of the bladder, and the ready lacerability of th
tissues. If, after the groove in the staff has been exposed, care be not taken to i
sinuate, as it were, the nail into the opening in the urethra thus made, the membr
nous portion may be torn across; and the neck of the bladder, receding before th
finger, may easily be pushed away from the surface, so that the surgeon may fail i
reaching the cavity of the organ. When the road is once lost in this way, there i
the very greatest difficulty in finding it again. The course that should be pursue
is, I think, as follows: If the staff have not been withdrawn, the surgeon must endeavor to pass it again
again place the knife in its groove, and carefully push it on towards the neck of the bladder
bladder, notching that structure and passing the finger cautiously along the groove
and hooking down the parts with his nail until he reach the inside of the bladder
Should the staff have been withdrawn, the surgeon must on *no account whatever* endeavor to introduce it
if he succeed in this, he may act as just stated; but if he cannot succeed in this, but
ducing the staff fairly into the bladder, he must on *no account whatever* endeavor to pass it again
to open that viscus, or continue his attempts at the extraction of the calculus, but
must at once abandon the operation until the parts have healed, when he can repeat
it. The great danger in these cases arises from the surgeon losing his presence of
mind, and endeavoring to enter the bladder without a guide—a procedure which
must be unsuccessful, and can only end in the destruction of the patient.

In adults, the difficulty is to get out the stone; in children, to get into the

3. *Difficulty in seizing and extracting the stone* is far more frequently met with
than in reaching the bladder. This may be owing to a variety of causes. It is
likely to happen in all those cases in which, either from the depth at which the
bladder lies from the surface, or from the peculiar position of the calculus, the
stone cannot be felt with the finger after the incisions have been made into the neck
of the bladder.

Difficulty from the position of the stone.—The calculus may be lodged *in the lower fundus* of the bladder, above the pubes, and have a deep perineum, perhaps with enlarged prostate, behind which the stone may be lodged. This constitutes the greatest difficulty. Here the best plan is to use a much-curved pair of forceps, and to tilt the bladder up by introducing the finger into the rectum, so as to bring the stone within reach.

When the stone is situated *in the upper fundus* of the bladder, above the pubes, it is altogether out of the axis of the incision, and in such a case can only be extracted with great difficulty. Aston Key recommends that in such cases the abdomen should be compressed, and the calculus thus pushed down into reach. This suggestion is a very useful one; and it was only by employing this manœuvre and using a very curved scoop, that I could remove a calculus lodged above the pubes, in the first patient whom I cut at the hospital, many years ago.

would probably be safer to perform the supra-pubic operation.

Difficulty depending upon the shape and size of the stone.—If the stone be very round, it is usually more difficult to seize than when flat or elongated. Flat, disk-shaped calculi, however, occasionally fall into the fundus of the bladder behind the prostate, and then cannot be readily reached by the forceps, which passes over them. In these circumstances, they are best extracted by the curved scoop. Very flat broad calculi and those that are round, egg-shaped, or branched, are the most difficult to remove, even though their size be not very great. As a general rule, however, it may be stated that, the larger the calculus, the more difficult is its extraction. This arises not so much from the outlet of the pelvis being too narrow, as from the necessity of making the internal incisions through the prostate to a very limited extent. There will always be considerable difficulty experienced in extracting calculi weighing six or eight ounces and upwards; though cases are recorded by Cheselden, Klein, and others, in which calculi from twelve to fifteen ounces in weight have been extracted by the lateral operation. Any calculus above one inch and a half in its shorter diameter will present considerable difficulties in being extracted through an incision in the prostate of the ordinary size; viz., not exceeding eight lines in length, even though this be considerably dilated by the pressure of the fingers; and I think it may be safely said, that a calculus two inches and upwards in diameter can scarcely be removed by the ordinary lateral operation with any degree of force which it is safe to employ. In the facility with which the calculus is extracted, however, much will depend upon the make of the forceps. As Liston most truly observes, "There can be no more fatal error than to attempt the extraction of a large stone with short and shabby forceps." In these cases I think the open-bladed forceps (Fig. 530) will be found useful, the absence of metal in the most convex part of the blade lessening materially the bulk of the instrument when grasping a stone.

Fig. 548.

Lithotomy crusher and drill for large calculi.

In the event of the calculus being too large to be extracted by the ordinary lateral operation, what course should the surgeon pursue? Three are open to him: 1. Division of the right side of the prostate from the interior of the wound; 2. Crushing the calculus in the bladder, and then removing it; and 3. The performance of the recto-vesical operation.

The *incision of the right side of the prostate* gives considerable additional space, and is sufficient for most ordinary purposes; very large calculi being fortunately very rarely met with. This section may be made by introducing into the wound a probe-pointed scalpel (Fig. 529), guided by the index-finger, and cautiously dividing the right side of the prostate downwards and outwards, in the same way that the section of the left has been made. This procedure must be carefully done, with due regard to the important parts in the neighborhood of the gland. In two cases I have seen Liston do this. In one the patient recovered, in the other he died of diffuse cellular inflammation of the pelvis; and I have had occasion to practice it once on a patient whom I cut at the hospital, and who made an excellent recovery.

The second plan, that of *crushing the calculus in the bladder* through the wound in the perineum, would certainly be a hazardous procedure. The irritation that would necessarily be set up by the large lithotrite or crusher (Fig. 548) that has been invented for this purpose, by the presence of the fragments of stone, and by the necessary difficulty and delay of clearing them out of the viscus, would probably be fatal to the patient. In the event of its being impossible to extract the calculus through the perineum, I think it would be safer to adopt the third course, and to perform the *recto-vesical operation*, which will presently be described. Should, however, the unusually large size of the

even in healthy subjects, is always a dangerous operation; and, though the rate
mortality doubtless depends greatly upon the dexterity and skill of the opera
more is, I believe, due to the constitution and age of the patient, and espec
to the state of his kidneys. Sir B. Brodie most justly says, "Success in lith
most undoubtedly depends in a great degree on the manual skill of the s
and on the mode in which the operation is performed; but it depends still
the conditions of the patient with respect to his general health, especial
existence or non-existence of organic disease." That the mere cuttin
bladder is not a very dangerous proceeding, provided that viscus and
be healthy, is evident from the fact that, in those cases in which surg
to extract bullets, bits of catheter, &c., from this organ, bad cons
rarely occurred, though the operations have often been tedious. I
case is different; for here the bladder is not only usually in a
irritation, but the kidneys are frequently diseased, and these co
the result of the operation more materially than any other circ
an operator may have a run of unsuccessful cases; or by a fort
favorable circumstances, more particularly in children, it has
that a surgeon has cut 20 or 30 patients in succession witho
but several deaths then occurring, though the operation wa
way and with the same care as before, his average had falle
Green, at St. Thomas's, cut 40 patients in succession, and
25 patients for stone without losing one, and he said th
discovered the secret of performing lithotomy with suc
mighty punished him for his presumption, for he lost
Bransby Cooper, of Guy's, cut 30 patients in succes
lost several, thus reducing the rate of mortality t
during a period of six years, in which he operated
lithotomy at University College Hospital; but o
cut during the period of his connection with the
reducing the average to 1 in 7.2. This success
taken into consideration that most of these cas
them were of a very serious character. I find
that only seven of the patients were under
50; of these, two were 80 years of age, of
I believe that Liston lost only one patien
of 18, in whom he found it necessary to d
as the left, and who died of infiltratio
sively operated on at the Norwich
mortality in that Institution, calculat
only lost one 1 in every 10¾; and,
tality has amounted to more than
probably children. Sir B. Brodie
London hospitals in the year 18
sible 1 in 6. But the more recer
show that the average mortalit
Coulson the average mortality
operation, is 1 in 6.93 cases;
rally 1 in 5.14. The mor
result for lateral lithotomy
there were 229 deaths, or
cases of lateral lithotor
being nearly the same
Age exercises a mor
condition. Lithotom
in surgery at early
dangerous one at
found to be four t
2972 cases of lith
follows. Below
years to 1 in 9
The reason

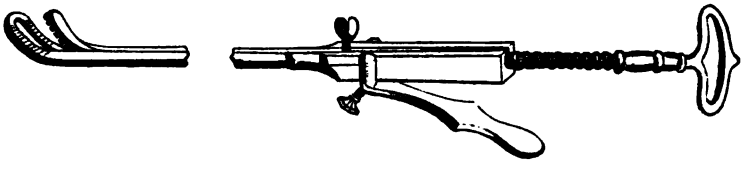
An ordinary *sound* with a short beak is required to examine the condition of the bladder. The steel sound should be hollow, so that the bladder may, if necessary, be injected through it after or during sounding, without the necessity of changing the instrument (Fig. 526). This will be found of much service in the later stages of the operation for detecting small fragments.

A *brass syringe*, with rings, and having a large piston rod, so that it may work easily, should be at hand, and admit of adaptation to the hollow sound.

The surgeon should also be provided with *silver catheters* of three different kinds: one with large lateral eyes, another with a large eye in the convexity, and a third with a large eye in the concavity near the point (Fig. 568); all having an elastic gum bougie fitted to the interior, instead of a stylet, to clear out the fragments (Fig. 569). These should also fit to the syringe.

The instrument for breaking the stone consists of a *lithotrite*, as represented in the annexed cuts (Figs. 556, 561, 562); or a similar instrument worked by a rack and pinion is employed by Fergusson. The lithotrite must be made of well-tempered steel; and should always be tested by being made to crush a piece of sandstone grit, of about the size of a walnut. It should be of as full a size as the urethra will readily admit; it must have the male blade well serrated, and the female or under blade open at the beak, with an oval aperture, through which the detritus of the crushed stone is forced, and thus any entanglement of it between the blades is prevented (Fig. 556).

Fig. 556.



Weiss's thumb-screw lithotrite for breaking the stone.

The object of this open-bladed lithotrite is to break the larger and harder stones into fragments; but it is not equally efficient with smaller calculi and fragments.

The lithotrite should be cut out of a bar of solid steel, and not, as is the case with some instruments, made of a plate of this metal, turned up at the edges; as such an one possesses too little strength to be used with safety on large and hard calculi. Those cut out of a bar of metal have an external blade, having a grooved shape, as in Fig. 560. In this, the male or internal branch, cut to fit accurately (Fig. 559), slides smoothly, the whole instrument possessing an amount of strength and power that no calculus can resist. The bent-up instrument is composed of an outer tube of metal, as represented in its transverse section (Fig. 558). in which the internal blade fits less accurately (Fig. 557), and which possesses less strength, especially at the elbow, than the lithotrite cut out of the solid. The scoop may, however, be so constructed without danger.

Fig. 557.

Fig. 559.

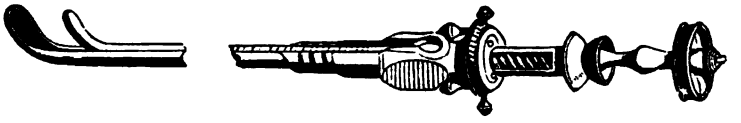
Fig. 558.

Fig. 560.

Civiale's lithotrite, such as is represented in Fig. 561, has a most ingenious double action, enabling the surgeon to work it either by the hand or by a screw. In this instrument, there is no fenestrum in the female blade. It is of two kinds. In one, the male blade is much narrower than the female; in the other, it is nearly as broad. The first kind is useful in crushing through moderate-sized stones; the second kind, with the broad male blade, is used in completely crushing up and removing the detritus of small calculi, and the larger fragments into which a stone has been broken by the open-bladed lithotrite.

Weiss and Thompson's lithotrite (Fig. 562) somewhat resembles Civiale's in its

Fig. 561.



Civiale's lithotrite for crushing fragments.

Fig. 562.

Weiss and Thompson's improved lithotrite.

action, but is more handy. It is made with a fenestrated female blade for breaking the stone, and has a scoop for crushing fragments.

Preparation of the Patient.—Before proceeding to the operation of lithotrity, it is necessary that the patient's constitution should be carefully attended to; the bowels should be freely opened, and the condition of the digestive organs regulated, and more especially that all local irritability about the urinary organs should be subdued by ordinary medical treatment. This is even of much greater importance in lithotrity than in lithotomy. In lithotrity, we must always expect that any existing irritation or inflammation of the bladder will be increased by the necessary introduction of instruments, and by the presence of sharp fragments of calculus in the bladder, and their passage along the urethra; but in lithotomy all source of irritation is at once removed by the extraction of the stone. The condition of the urinary organs must be very carefully examined: and, if these be diseased, it will probably be requisite to abandon the operation.

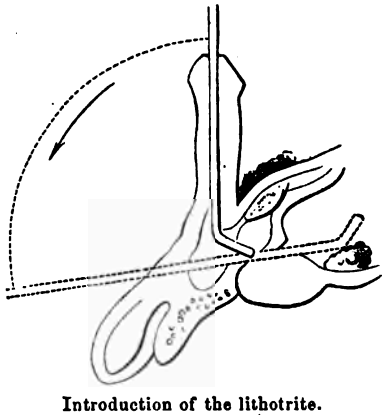
In a subsequent part of this chapter, when we come to the comparison of lithotomy and lithotrity, we shall examine the conditions which either indicate or negative the performance of the latter operation. At present, we will suppose a case in which the surgeon may have recourse to lithotrity with every prospect of readily and permanently freeing the patient of his calculus; one in which the calculus is of moderate size, single, and not too hard; the urinary organs healthy, and not over sensitive; and the patient an adult, but not too aged. In performing the operation in such a case, but little preparatory treatment is required; though it is well to keep the patient quiet for a few days, and to regulate his bowels before anything is done. Should the patient's health not be in a satisfactory state, or should his urinary organs be irritable, he must be treated on ordinary medical principles until his health be sufficiently restored for the surgeon safely to undertake an operation. Should the patient be nervous about the use of instruments, or should the urethra be irritable, a large sound may be passed every second day, so as to accustom the patient and the parts to the use and contact of instruments.

Use of Anæsthetics.—Much difference of opinion exists as to the advisability of employing chloroform in lithotrity. It has been objected to its use that the sensations of the patient are a useful guide to the surgeon in his manipulations; and that, if these be annihilated by anæsthetics, injury may be done by the lithotrite nipping or otherwise bruising the mucous membrane. But this objection is not tenable. It is the sensations of the surgeon, and not those of the patient, that constitute a valuable guide; although in the majority of cases lithotrity, when properly performed, is almost a painless procedure. Yet cases not unfrequently occur in which the patient can with difficulty support the necessary manipulations, and in which, either from nervousness or from irritability of the bladder, he ejects his urine on the introduction of the lithotrite, or even does not allow his bladder to be duly distended by injection. In such cases chloroform is of inestimable service; and many patients when anæsthetized can be safely subjected to lithotrity, who could not suffer the operation under other circumstances.

Operation.—The operation of lithotrity may be divided into three stages: 1. The introduction of the instrument. 2. The search for and seizure of the stone. 3. The crushing of the stone.

1. *Introduction of the lithotrite.*—Lithotrity may most conveniently be performed with the patient lying on his back either upon a hard mattress, or on a couch or table. If the patient be very stout, or the prostate enlarged, the pelvis may be raised by a hard pillow, so as to allow the stone to roll up on the posterior surface of the bladder. The surgeon, standing on the right side of the patient, carefully introduces the hollow sound, or catheter, and draws off the urine; he then slowly, and very cautiously, injects the bladder, by means of the brass syringe, with from four to six ounces of tepid water. The use of drawing off the urine is to make sure of the bladder holding the proper quantity of fluid when it is afterwards injected; and the object in injecting it, is to distend it with fluid to such an extent as to prevent the mucous membrane from being seized in the grasp of the lithotrite, or injured by the splintering of the stone. The instrument is then withdrawn, after the situation of the stone has been detected by it, and the lithotrite is introduced. Should the patient be able to hold enough urine to protect his bladder from the action of the lithotrite or the fragments, the injection may be dispensed with, and the lithotrite may at once be used. As this is straight, with a sharp elbow near the beak, some little skill is required in passing it. In doing this the surgeon must keep his eye upon the short curved beak of the instrument, the direction and position of which must be constantly observed or rather judged of; and especial care must be taken, in carrying it under the pubes, not to injure the urethra by pushing the beak of the lithotrite forwards too suddenly, instead of winding it, as it were, under the arch of that bone. The instrument should first be introduced nearly parallel to the abdomen, the penis being held between the left fore and middle fingers, and drawn over it. As the lithotrite passes down, it must be gradually raised to the perpendicular position; and as its curve passes under the pubes, the handle should be depressed between the thighs (Fig. 563). The direction of the curve is the thing to bear in mind; and the position of the handle must be varied in accordance with the course which this takes. The lithotrite should be well greased with olive oil, so that the branch and screw may work smoothly. Lard or ointment should not be used for this purpose, as it is apt to clog, and to entangle gritty bits of calculus.

Fig. 563.

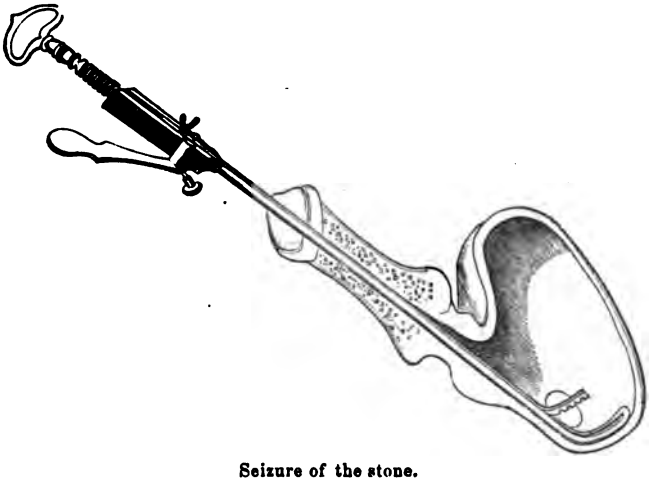


Introduction of the lithotrite.

2. *Seizure of the stone.*—The next point is to seize the stone, which will generally be found in the situation where its presence was detected during the sounding of the bladder. If large, the stone will probably lie low, near the neck of the bladder; if small, it is most frequently met with at the right side, or at the inferior fundus. Should it be situated in a sacculus or depression in this region, it may most readily be seized by introducing a finger into the rectum, and raising up the lower part of the bladder; or, better still, by raising the pelvis on a hard pillow, and so causing the stone to roll up on the posterior surface. Brodie strongly advises that the lithotrite should never be used as a sound to ascertain the position of the stone; if this be done, the patient suffers pain, the bladder is irritated, the urine is expelled, and the stone not readily seized. In seizing the calculus, a good deal of tact is required. There are two ways of seizing the stone. Brodie recommends that it should be done by pushing the female blade of the lithotrite against the inferior fundus of the bladder, pressing gently down with it so as to make a conical depression in this situation, and then inclining the beak towards the stone, drawing back the male blade with the thumb (Fig. 564); with a slight shake or jerk, the surgeon then tries to get the calculus between the blades, at the same time that the male branch is being pushed forwards to seize it. In this manœuvre the female blade should be moved as little as possible, but the stone must be seized by pressing the thumb upon the half-circle of steel fixed on the male branch. In this way the stone may often be seized at the first attempt, but in other cases it is not grasped until after several efforts have been made to fix it; the calculus, especially if round, slipping away from between the blades of the instrument, and being merely scraped

by them. Civiale adopted another procedure. In passing the lithotrite, he felt where the stone lay; he then very gently turned the beak of the instrument towards

Fig. 564.

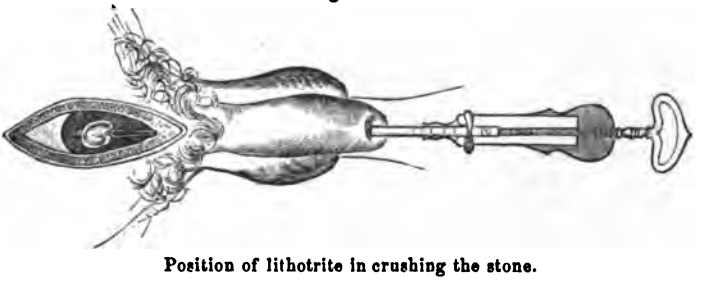


Seizure of the stone.

the opposite side of the bladder, opened the blades, and then, turning them over towards the stone, seized it between the open blades. In these manœuvres, all rough handling must be most carefully avoided, and the instrument should be turned about as little as possible. It is far safer to desist in the operation, if there be any difficulty in seizing the stone, than to persevere in repeated and fruitless attempts, by which the bladder may be severely injured and inflamed. Rather than do this, the patient should be allowed to get up and move about for a few minutes, when the position of the stone may be so far altered that it will admit of being seized.

3. *Breaking the stone.*—When the stone has been seized, it is gently raised in the

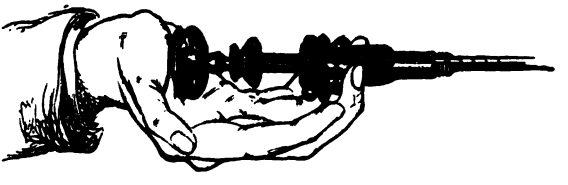
Fig. 565.



Position of lithotrite in crushing the stone.

grasp of the lithotrite, so as to be placed about the middle of the bladder, and it is then crushed. This important step of the operation, like all the others, requires to

Fig. 566.



Position of hand in using Civiale's lithotrite.

be deliberately and carefully done (Fig. 565). If Civiale's improved lithotrite be used, the stone, if small, may often readily be crushed by the pressure of the hand

employed, the breaking should not be effected by suddenly and forcibly screwing up the instrument, but the screw should be gradually worked by a series of short and sharp turns, so as to constitute almost percussive movements (Fig. 567). In this

Fig. 567.

Position of hands in using ordinary lithotrite.

way the calculus is generally made to crumble down, rather than to fly asunder; and, as it yields, the screw must be worked tightly home. The blades of the instrument may then be opened again, a fragment of the broken calculus seized and crushed in the same way as before; and thus the disintegration of the stone is in a great measure effected and sometimes completed at one sitting. It is of the greatest moment, however, that too much time be not consumed at one sitting. Nothing is more dangerous than the long-continued contact of instruments with the interior of the bladder; in this way great irritability, or an atonic condition of this organ, terminating in low cystitis and pyæmia, is apt to be produced, and death may thus result. The shorter the sittings, the more likely will the case do well. The first sitting should not exceed ten minutes, and the subsequent ones five. In the repetition of the sittings, the surgeon must be guided by the effect produced on the stone and on the bladder. The calculus may be entirely destroyed in one sitting, but most commonly from three to five or six are required; these should, if possible, be conducted at intervals of three or four days, though this must depend upon the amount of irritation induced by them.

At the first sitting, it is sufficient to break up the stone; the fragments being left to be dealt with subsequently. This sitting is by far the most important of all; it should not occupy more than about ten minutes. After the stone has been broken up, the patient should be made to lie in bed on his back for about twenty-four hours, be kept warm, and be plentifully supplied with diluents. He should pass water in an urinal, and not be allowed to stand up or to lean forward, lest the fragments fall against or become fixed on the neck of the bladder, where they may produce great irritation and distress. Much of the success of lithotrity will depend upon the gentleness with which the proceedings are conducted during the first sitting, and the care with which the patient is managed for a day or two subsequently.

Before withdrawing the lithotrite, the surgeon must be careful to see, by the scale on the handle, that the male blade is well home. If this be not the case, and the instrument be enlarged by any fragments or detritus being entangled between the blades, laceration of the neck of the bladder or urethra might occur in attempting to withdraw it.

After the stone has been broken, little detritus will usually escape during the first twenty-four hours; but after this it is expelled, in some cases in considerable quantity, each time the urine is passed. In others, it does not escape so readily; and then the surgeon requires to introduce Civiale's instrument (Fig. 561), by which he can seize the smaller fragments, crush them, and, screwing the instrument home, extract the beak filled with detritus. In using this instrument, however, care must be taken not to get hold of too large a fragment; for in breaking this up, whether by the hand or screw, the beak may be clogged with the detritus in such a way that it does not readily close, and then there might be considerable difficulty in withdrawing it. Should this accident occur, the scoop may be emptied by passing its beak back into the bladder, tapping sharply upon the instrument, and moving the male branch to and fro. In crushing fragments behind the prostate, Civiale turned the concave part of the beak downwards, and seized the fragment in this position. In doing this, however, great care must be taken not to nip the mucous membrane of the bladder.

this point the opinions of surgeons differ much; and it is particularly in the management of these cases that the advantage of the tact and dexterity in the use of the crushing instruments, which habit can alone give, is so well exemplified.

The condition of the *kidneys* merits special attention. If these organs be diseased, as indicated by the presence of casts of tubes, or of a considerable quantity of albumen in the urine, or in any other way, the performance of a series of operations in the bladder would be likely materially to increase the mischief in them, and consequently ought not to be undertaken. Organic disease of the kidneys is a more serious obstacle to lithotrity than to lithotomy, on account of the prolonged nature of the operation, and the greater liability to sympathetic or prolonged irritation in these organs, giving rise to purulent nephritis. It is not only by the operation increasing the renal mischief that harm might result, but also in consequence of the tendency to low and diffuse inflammation of the bladder, prostate, and surrounding areolar planes, and to pyæmia, that always coexists with kidney-disease.

The conditions of the *bladder* that interfere seriously with lithotrity are partly functional, partly organic. The functional derangements are of two very opposite kinds; viz., a state of extreme irritability of the organ, and an abnormal want of sensibility of it—a state of atony. The organic lesions consist of hypertrophied, fasciculated, sacculated, and permanently contracted states of the viscus, which is then most commonly irritable as well.

A *chronically inflamed or irritable* state of the bladder, more particularly if the organ be thickened and fasciculated, so that it will not bear the injection of a few ounces of tepid water, seriously interferes with the success of lithotrity. A very irritable and sensitive bladder not only will be the seat of severe suffering on the introduction of instruments, but may not admit of holding sufficient urine to make the operation a safe one, and may readily become dangerously inflamed in consequence of the repeated introduction of instruments, and the presence of angular fragments. Hence, if the ordinary operation of sounding occasion much distress; if the patient cannot hold his urine long, but pass it in small quantities; if it be bloody or much loaded with viscid mucus, he will scarcely be able to bear the procedures necessary for the operation. In some instances, however, the irritability of the bladder may be overcome, and in all it may be materially lessened, by keeping the patient in bed, and, as Brodie recommends, daily injecting tepid water. If the bladder be *sacculated*, there will be a still greater risk of an unfavorable result; the sacculi not only retaining fragments of calculus, but also becoming the seats of unhealthy inflammation, in consequence of which typhoid cystitis of a very serious character, followed by pyæmic symptoms and metastatic abscesses, may result. In such cases as these, lithotomy offers the only chance to the patient. The existence of a moderate amount of vesical catarrh, if the bladder be otherwise healthy, is no objection to lithotrity.

In *encysted calculus*, lithotrity is, for obvious reasons, inadmissible.

Atony of the bladder is not only a serious inconvenience, but a great source of danger in lithotrity. It cannot in all cases be positively ascertained beforehand; though it may be suspected if the patient can hold his urine for a great many hours, and can bear without complaint the injection of a large quantity—eight or ten ounces—of fluid, the interior of the bladder feeling large and smooth to the sound. This condition chiefly occurs in old men of feeble habit of body; and, if ascertained, calls for the performance of lithotomy. As Civiale has pointed out, this condition may be a source of great danger after lithotrity, the organ not possessing sufficient expulsive power to rid itself of the fragments with which it is encumbered, and of the presence of which it seems to be insensible, so far as the feelings of the patient are concerned; while its low vitality renders it peculiarly liable to subacute cystitis, excited by the presence of the fragments in the lower fundus. It must be borne in mind, that this atony of the bladder may, especially in feeble and aged individuals, be induced by the contact of the instrument, and especially by prolonged sittings.

If the *urethra* be the seat of stricture, or be very irritable, lithotrity—which may require the frequent introduction of instruments of large size, and will entail the continued passage of fragments of calculus—cannot be performed. Stricture of the urethra does not, however, absolutely prevent the performance of lithotrity, but only retards the operation until the constriction can be properly dilated. Should this, however, not be practicable to the full extent of the urethra, lithotomy on a small staff must be practised.

Moderate enlargement of the *prostate*, such as is habitually met with in elderly people, does not necessarily prevent the performance of lithotrity; though it undoubtedly complicates the operation. The introduction of the lithotrite will be attended by considerable difficulty; and the fragments have a tendency to become lodged in a pouch of the lower fundus behind the enlarged gland. This more especially happens if the middle lobe be enlarged; and in these circumstances, though the stone may undoubtedly be crushed, yet the fragments would probably require to be removed by the scoop; the operation would consequently be very tedious and prolonged, and lithotomy would probably be found to answer best. Any inflammatory disease or abscess of the prostate must necessarily prevent the performance of lithotrity.

I have said nothing in this comparison between lithotrity and lithotomy of the comparative painfulness of the two operations; for, as chloroform may be administered with equal advantage in both cases, there is little difference in this respect, except that perhaps the advantage lies on the side of lithotomy, as being the shorter proceeding.

From all that precedes, then, it would appear that, useful as lithotrity unquestionably is in many cases, it cannot be looked upon as a general means of treating stone in the bladder; being only safely applicable in favorable conditions of the urinary organs, to calculi of small, or, at most, but moderate size, and after puberty; and that a large number of cases will always be left in which lithotomy offers the sole means of relief.

Choice of Operation of Lithotomy.—The particular operation of lithotomy that should be had recourse to, will also vary according to the character of the stone. If this be of small size, and the patient an adult, the *median* operation may advantageously be performed. If it be of moderate or tolerably large size, and more particularly if the operation be practised on a child, the *lateral* appears to me to be the more applicable. If, again, the calculus be of inordinate magnitude, the *suprapubic*, the *medio-bilateral*, or the *recto-vesical* operation should be the method selected. In fact, the surgeon should not confine himself too exclusively to any one method of operating, but should adopt that procedure which appears to be best adapted to the special circumstances presented by the particular case before him, and should vary his method according to the state of the urinary organs, the age of the patient, and the size and character of the stone.

The Result of Operation for Stone will depend in a great measure upon the condition of the bladder, and the character of the stone. If the bladder be healthy, all symptoms will cease on the removal of the calculus, and the patient will be restored to perfect health. This usually happens when the calculus is of the lithic acid or oxalate of lime varieties, and of renal origin. If, however, the bladder be unsound, irritable, and disposed to the secretion of phosphatic matters, the calculus being phosphatic, and chiefly, if not wholly, vesical in its origin, then an irritable state of bladder may be left or may speedily return after the operation, which will consequently have been productive of little, or only of temporary benefit.

Recurrence of Calculus after Operation.—This may take place from three distinct causes: 1, in consequence of a continuance of the constitutional condition or diathesis, under the influence of which the calculus was originally formed; 2, from the descent of a renal calculus; and, 3, from a fragment of calculus having been accidentally left in the bladder.

Relapse from the first cause is probably not very common: but its occasional occurrence shows the necessity of continuing constitutional treatment adapted to the particular diathesis, after the removal of the calculus from the bladder. It is relapse from this cause that probably occurs in cases of lithotomy; though even in this operation a fragment of calculus may accidentally be broken off during extraction, and left. Yet such an accident is not very frequent; for, if the calculus happen to be broken during extraction, the fragments, if not completely cleared out of the bladder, will usually be washed away through the wound by the flow of urine. The registers of the Norwich Hospital show 1 relapse in 58 cases; and those of Luneville, 1 in 116 cases of lithotomy (Coulson).

After lithotrity, on the other hand, relapse is more common; although it is probably less frequent now than formerly, and will become less frequent as the details of the operation come to be better understood, and are more carefully practised. In the practice of Civiale it has occurred about once in every tenth case. But this esti-

mate, high as it is, falls below what happens in surgical practice generally. Civiale states that, of 36 private patients on whom he operated in 1860, 10 had previously been operated on, the stone having reappeared. This must evidently arise from some fragment of calculus having escaped detection and being left behind, thus constituting a nucleus for a fresh formation. The frequency of the occurrence of secondary calculi after lithotrity, even in such practised hands as Civiale's, if it does not constitute an objection to that operation, shows the necessity of the surgeon most carefully examining the bladder before he pronounces the patient cured; and even then watching him for some length of time, in order to meet the recurrent calculus at its first formation, and to adopt means for its early removal. Lithotrity cannot therefore be said to be so complete a cure in all cases as lithotomy. Not only is recurrence of calculus more common after the former than after the latter operation, but it not uncommonly happens that patients who have been lithotrised successfully, and in whom no recurrent calculus has formed, continue to suffer for a great length of time afterwards from very distressing irritability of the bladder, which resists in the most obstinate manner all the ordinary methods of treatment. This is not the case after lithotomy: when a patient once recovers, his bladder usually regains its tone completely, and no trace of evil consequences is left.

Treatment.—In the event of a secondary calculus forming, whether after lithotomy or lithotrity, either method may again be employed, according to the nature of the case. If lithotomy have previously been performed, and it be thought proper again to have recourse to it, this may be done again in the usual way, through the cicatrix left by the former wound; or the surgeon may adopt Liston's advice to cut through the right side of the perineum on a staff with a groove to the left of its convexity. As this procedure, however, would entail the use of the left hand for cutting and extracting, most surgeons would, I think, prefer either the operation through the site of the old wound, or else the median operation. Whatever procedure, however, may be adopted, it should be borne in mind that the rectum may have become rather firmly adherent to the membranous portion of the urethra and the apex of the prostate, in consequence of the contraction of the old cicatrix, and may thus be endangered.

[The *recto-vesical* operation, which is several times referred to though not described by the author, is performed by thrusting the point of a knife (guarded by the left forefinger) through the prostate, from the rectal surface, into the groove of the staff held in the ordinary position, and then cutting upwards and outwards through the sphincter and perineum. This operation, devised by Sanson, has been modified by Maisonneuve so as not to divide the sphincter. It is seldom performed.—A.]

URETHRAL CALCULUS.

Calculi are not unfrequently found impacted in the urethra, especially in children. They may be formed in two ways; first and most commonly in the kidney, whence they pass into the bladder, and thence into the urinary canal, through which they usually escape, but in other instances lodge in it, more especially at the bulb or in the navicular fossa. These calculi are commonly of the lithic acid or oxalate of lime varieties; they are frequently round, but not uncommonly elongated or spindle-shaped. But, although most urethral calculi are undoubtedly renal in their origin, there can be little doubt that in some more rare cases they may be primarily formed in the canal. They will then be found to be phosphatic, are usually consequent upon stricture, and may attain a large size. In some cases these concretions are moulded in the prostatic and bulbous portions of the urethra, being elongated, rounded at one end, and pointed at the other. In other instances, again, they appear to be formed in a pouch that lies to the outside of the urethra, and that is only connected with it by a small aperture. I have removed a stone of this kind composed of triple phosphates, weighing an ounce, and about the size of a walnut, smooth and rounded, from a point lying between the upper wall of the urethra and the symphysis

Fig. 572.

Urethral calculus.

pubis, in a clergyman who had for many years suffered from very tight stricture. One of the most remarkable instances of this kind is represented in the annexed cut (Fig. 572), taken from a drawing in Sir R. Carswell's collection at University College. The stone here was of very large size—equal in bulk to two horse-chestnuts.

Symptoms.—The presence of a calculus in the urethra may always be determined by the difficulty that is occasioned in micturition, and by the possibility of feeling the stone through the walls of the canal, or of detecting it by introducing a sound into the urethra.

Treatment.—The removal of these calculi may be effected either by extraction or by excision. When situated towards the anterior part of the canal, a urethral calculus may frequently be extracted by quietly working the stone forwards between the finger and thumb, the patient being under chloroform. Should this plan not succeed, it may be removed by passing a long and very narrow-bladed pair of forceps down to it, by which it is seized and drawn forwards; occasionally, when it has reached the navicular fossa, it will not pass through the urethral orifice unless this be dilated by incision with a probe-pointed bistoury. If the calculus be too large to be extracted in this way, and appear to be firmly fixed, an incision may be made down upon it, through the urethra, by which it may be removed. It is a good rule not to make this incision in any part of the urethra anterior to the scrotum; for, in consequence of the coverings of the penile portion of the urethra being very thin, the aperture will probably not be closed, but a fistulous opening left. When the stone is situated in the scrotal portion of the urethra, there would be some risk of abscess and of urinary infiltration if the incision were made through the lax tissues of the scrotum. Hence it is better, if possible, to push the stone back towards the membranous portion of the canal, to cut down upon it, and extract it here. This operation may readily be done by passing a staff, grooved along its convexity, or an ordinary director, as far as the calculus, and making an incision upon the end of it, so as to lay open the urethra; the staff is then removed, and the calculus extracted by means of a slender pair of forceps. A catheter should next be passed into the bladder, and retained there for a few days, in order to lessen the tendency to the formation of urinary fistula.

It may happen that the calculus, impacted in the urethra, is only one of several; others being lodged in the bladder. In order to ascertain this, the surgeon should, after removing the calculus for which the operation has been performed, pass a sound into the bladder, so as to ascertain whether any other concretions exist in that organ; and if so, they should at once be removed by extending the incision of the membranous portion of the urethra into the bladder, by the median operation of lithotomy. I once saw Liston extract two vesical calculi, after having removed one that had blocked up the urethra, by converting the perineal incision into that of lateral lithotomy.

The *impaction of a calculus* in the deeper portion of the urethra of a boy may lead to very serious consequences. In the majority of instances it occasions more or less complete retention of urine, which requires relief; either, if the calculus be deeply seated, by pushing it back into the bladder, extracting it by the urethral orifice if practicable, or cutting it out through the perineum. But another, and perhaps more serious evil than this even, has occasionally been met with; viz., the ulceration of the urethra by the pressure of the stone, which escapes into the areolar tissue, the formation of urinary abscess in the perineum, followed, perhaps, by the extravasation of urine into the scrotum, and its diffusion along the superficial fascia in the usual direction, and with the ordinary disastrous results of inflammation and sloughing that accompany and follow such infiltration.

In such cases as these, the child, after suffering from the ordinary symptoms of vesical calculus, will become affected by intense irritability of bladder, the urine passing with much pain every few minutes; or incontinence even will set in. Some purulent discharge will be observed about the meatus, and there will be some hard ill-defined swelling in the perineum, with much tenderness in this region. On passing a sound, no stone probably will be found, as this has escaped from the urethra, and is lying in a pouch in some part of the perineum, and in the midst of broken down areolar tissue and pus; into this cavity the sound will readily pass. The *treatment* in these cases is simple. It consists of introducing a grooved staff, placing the child in the lithotomy position, and then freely incising the mesial line of the perineum, so as to open up the urinary abscess; in this the stone may be found, or it may

through the wound in a few days, and be found lying on the bed. Should there be much hemorrhage, a petticoated lithotomy tube should be introduced. If extravasation of urine have occurred, free incisions must be made in the usual way, and the child be put upon a series of stimulating diets.

PROSTATIC CALCULUS.

Prostatic calculus differs from all other urinary concretions in situation and composition, being formed in the ducts of the prostate gland, and composed principally of phosphate of lime and some animal matter; usually about 85 per cent. of the phosphate, to 15 of the organic ingredient. Sometimes, also, the concretion is said to consist of carbonate of lime (p. 1030). It generally occurs in old people, though it may sometimes be met with in young subjects. From a lad of nineteen, whom I cut for vesical calculus, I extracted two prostatic concretions.

Characters.—Prostatic calculus is usually of a gray or ashy color, somewhat triangular in outline, smooth and polished (Fig. 573); having facets, being very hard, and seldom much larger than a cherry or plumstone; though it may occasionally attain a considerable bulk, having been met with as large as a hen's egg, and then presenting a branched or irregular appearance. Though usually but one or two exist, which are sometimes deposited in a kind of cyst in the organ, as many as thirty or forty have been met with, the ducts being filled, and its whole tissue being studded with them.

Fig. 573.

Prostatic calculus.

Symptoms.—Calculus in the prostate gives rise to a sense of weight, pain and irritation in the perineum, sometimes to retention of urine, and, in fact, to the ordinary symptoms of enlarged and irritated prostate; it often occasions a tolerably free secretion of mucus in the urine. On introducing a sound, this passes over the stone, sometimes rubbing or striking it with a distinct grate or click before its beak enters the bladder. This is increased by the finger in the rectum pushing the organ up, and thus bringing the stone into more direct contact with the sound. In some instances the calculus is deeply imbedded in the prostate, and cannot be touched by the sound. In these cases the stone may usually be felt through the rectum. If there be many small calculi in a sacculus in the prostate, they may be felt by introducing the finger into the rectum, when a peculiar crackling or grating sensation may be experienced by the rubbing together of the calculi, something like that produced by beads in a bag.

Treatment.—The treatment of prostatic calculus will depend upon the situation, size, and number of the concretions. When they are large, single, or at most two or three in number, readily struck with the sound, and situated on the urethral surface of the organ, the ordinary median operation may advantageously be performed, and the calculus removed with a scoop or forceps. If the calculi be small and very numerous, not to be felt with sound, but only through the rectum, it will be wiser not to have recourse to operation, which could not succeed in removing the whole of the concretions. In such circumstances, a palliative treatment directed to the subdual of the irritation of the prostate, and the use of the catheter to relieve retention, is the only course to pursue. When prostatic and vesical calculus occur together, the same operation will rid the patient of both forms of the disease.

CALCULUS IN THE FEMALE.

Stone is of rare occurrence in women; in London, certainly, it is not often met with. Thus, South states that, during a period of twenty-three years, 144 males were operated on for stone at St. Thomas's Hospital, and only 2 females. In some districts, however, stone would appear to be more common in women than this. Thus, according to Crosse, at the Norwich Hospital, the proportion has been about 1 woman to 19 men. Civiale states, as the result of his researches, that in the north of Italy, the proportion is 1 to 18; and in France, about 1 to 22. Calculus in women is most frequently deposited upon foreign bodies, accidentally or purposely introduced into the bladder, such as pins, pieces of pencil, &c.

At the University College Hospital we had not had a case of stone in the female

for many years until 1855, when three came under my care in the course of a few months: and since that period several have occurred.

Symptoms.—The symptoms of stone in the female closely resemble those that occur in the male, and its presence may usually be easily detected by means of a short and nearly straight sound, or a female catheter. It is often simulated very closely by the irritation occasioned by a vascular urethral tumor, or by an irritable bladder; but exploration of the viscus will always determine the diagnosis.

Large calculi may be met with in very young female children. I have removed a uric acid calculus incrusted with phosphates, measuring 1¼ inch in length by ¾ inch in breadth, from a little girl four years old. The stone was removed unbroken, by gradual dilatation of the urethra.

In the adult they may attain a very large size. I have extracted one from a young woman measuring 8 inches in its long, and 6 inches in its short circumference.

Calculus in the female bladder, if allowed to remain unrelieved, will not only occasion the various morbid conditions in the urinary organs that have been described as following the long continued presence of stone in the male, but will give rise to diseased states peculiar to the female. Thus the stone may be spontaneously discharged through the urethra; if of small size, without any bad results following; but if large, by a process of ulceration, in consequence of which permanent incontinence of urine will remain: or it may slough through into the vagina: or lastly, it may offer a serious obstacle during parturition to the descent of the fœtal head, when, if it cannot be pushed aside to be dealt with afterwards, it must be cut out or craniotomy be performed.

Removal.—A stone may be extracted from the female bladder by one of three methods: 1, by lithectasy, through a dilated urethra; 2 by lithotomy; 3, by lithotrity. These different operations cannot be employed indiscriminately, but each one is more especially adapted to certain kinds of calculus.

1. **Lithectasy** may be performed in two ways—either by simply *dilating the urethra* by means of a sponge-tent or dilator, or else by *incising the mucous membrane* at the same time that the canal is being expanded.

a. Simple dilatation of the urethra may be effected quickly by the introduction of a tent of compressed sponge, or a three-bladed dilator, which is rapidly screwed up. In this way, in from a few minutes to two hours the canal may be easily dilated sufficiently to admit of the introduction of a pair of forceps, and the extraction of a calculus of moderate size. Some surgeons prefer a slow process of dilatation, continued through many hours; but this appears to me to possess no advantage over the more rapid expansion, and has the very decided disadvantage of prolonging the patient's sufferings. The plan that I have adopted with success is to introduce a sponge-tent two hours before the intended extraction; and then, when the patient is under the influence of chloroform, to dilate the urethra to the required extent with a two- or three-bladed dilator, or with the forceps used for extraction.

b. Incision may be employed conjointly with dilatation, in order to prevent injurious stretching of the urethra, and consequent laceration of its mucous membrane. The incisions recommended with this view should be made after the urethra has been dilated to some extent, a probe-pointed bistoury being introduced by the side of the canal, and the mucous membrane divided. Brodie made an incision directly upwards; Liston downwards and outwards on each side—on the whole, I think, the best direction for the incisions, as more space may thus be obtained.

By dilatation, either alone or with incision of the mucous membrane, small stones may readily be extracted; but in the removal of moderate sized calculi, the great objection to this operation is the liability to incontinence of urine resulting from it. It is difficult to say to what extent the urethra may be dilated without incontinence resulting; this must necessarily vary in different individuals. It certainly can be expanded sufficiently to admit of the introduction of the index-finger, and to allow of the extraction of a stone eight or ten lines in diameter, without any evil resulting. The incontinence of urine that may be left after the removal of larger calculi than this may not be by any means complete; but a weakened state of the sphincter of the bladder results, so that the patient cannot hold her urine for more than an hour or two at the most.

2. **Lithotomy** in the female may be performed in a variety of ways. There are, however, only two modes of practising this operation that appear to me to deserve serious attention; viz., the *supra-pubic* and the *vaginal*.

from the same procedure in men; except that it requires additional care in consequence of the difficulty there is in causing the female bladder to retain enough urine to make the viscus rise sufficiently above the pubes. The extraction of the stone is easy, as it can be raised into the grasp of the forceps by being pushed up from the vagina.

Vaginal lithotomy is an operation easy of performance. It may be practised by passing a straight grooved staff into the bladder, pressing the end well down against the anterior wall of the vagina, and fixing it there with the left index-finger. A scalpel is then pushed through the anterior wall of the vagina and inferior fundus of the bladder into the groove in the staff, which is made to enter just behind the urethra, and is then run backwards for about 1½ inch; through the aperture thus made the forceps is passed, and the stone extracted. The incision into the bladder through the anterior vaginal wall should be brought together by metallic sutures, as in ordinary operations for vesico-vaginal fistula, and may thus be successfully closed, as has been done by J. Lane, Aveling, and others.

Both the high and the vaginal operations are easy of performance. In the high operation, there would, with care, be but little risk of injuring the peritoneum; and the chance of urinary infiltration, which is a serious objection in the male, may be prevented in the female by the introduction of a siphon catheter into the urethra. The vaginal operation, though easier of performance, is open to the objection of possibly leaving a permanent urinary fistula. If, however, the lips of the incision have not been bruised by the forceps, or in the extraction of the stone, and be immediately brought together by metallic sutures, the risk of a fistula is, after all, not great. Vaginal lithotomy may, in some cases, be the only alternative. I extracted, by this operation, a calculus measuring eight inches by six in circumference, from the bladder of a woman twenty-three years of age, who had suffered from symptoms of stone from childhood. The stone by its size offered so serious an obstacle to the descent of the fœtal head during parturition, that craniotomy had been rendered necessary; the anterior vaginal wall had been a good deal bruised, and I feared that sloughing of it might take place; hence I extracted the stone by the vaginal method. Lithotomy is not so dangerous an operation in the female as in the male; yet death occasionally occurs, more particularly in feeble children, from cystitis and peritonitis, more particularly if the extraction of the stone have been tedious and deficient, the bladder being much manipulated.

3. **Lithotrity** in the female requires to be practised on the same principles as in the male. The details of the operation differ, however, in some important particulars. The chief difficulty in the performance of the operation in the female, consists in causing the bladder to retain urine or water that is injected into it. In consequence of this there is not only great difficulty in seizing the stone, the bladder collapsing and falling into folds around it, but also danger of injuring the mucous membrane with the lithotrite. In order to cause the bladder to retain the necessary quantity of urine, the pelvis must be well tilted up, and the urethra compressed against the lithotrite. It is well not to dilate the urethra before the introduction of the instrument, as the incontinence is thereby increased.

The ordinary male lithotrite is not a very convenient instrument to use in the female bladder, the handle being awkwardly long. This is especially the case in female children. Hence I have found it convenient to have a shorter instrument constructed, with which it is far more easy to manipulate in the female bladder. If urine or water cannot be retained, the calculus may more safely be seized and crushed by means of a small and strong-bladed pair of lithotomy-forceps; or, if the stone be larger, by a crushing instrument, made of the shape of that depicted in Fig. 574. In performing lithotrity in the female it is not necessary to pulverize the calculus, but merely to break it up into fragments of such a size as to admit of easy extraction through the urethra.

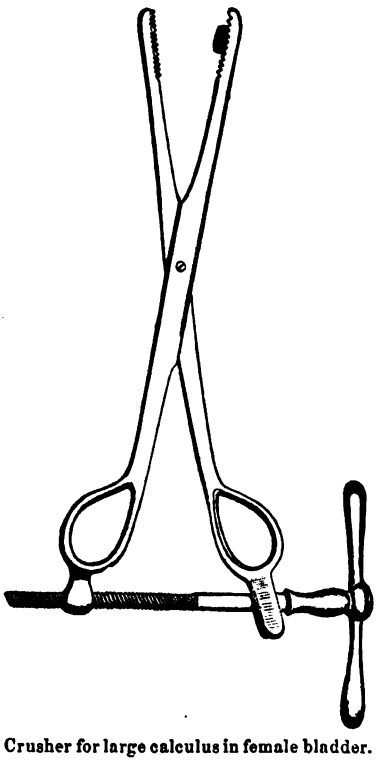
After the stone has been broken up, the urethra (unless this have been previously done) may be dilated by means of the two-bladed instrument, to a moderate degree, the larger fragments removed by means of a pair of slender forceps, and the detritus and smaller fragments cleared out of the bladder by repeated injections of tepid water. The whole of the fragments and detritus should be removed at one sitting. The shortness and wide capacity of the female urethra will readily allow

the escape of any detritus that may unavoidably be left.

For all calculi in the female bladder, except those of the very largest size, this operation is the most applicable. I have in this way crushed and extracted at one sitting, from the bladder of a lady about 50 years of age, a calculus (phosphatic) fully as large as a hen's egg. By this operation the stone may be removed piecemeal at once, without the necessity of dilating the urethra to such a degree as to incur the risk of incontinence of urine resulting. Lithotrity may be had recourse to at all ages, in the very young as well as the old. I have crushed and successfully removed a large calculus from a child three and a half years of age, the youngest patient on whom I have operated by this method. Although the urethra of so young a female child is not very dilatable, yet it can readily, by means of a sponge-tent, be enlarged sufficiently to admit an 11 or 12 lithotrite.

Foreign bodies of various kinds, such as hair-pins, pieces of stick, straw, &c., are not unfrequently introduced into the female bladder, where they produce irritation and give rise to symptoms simulating those of stone, and eventually become incrusted by phosphatic matter. By dilating the urethra to a sufficient extent, they may usually be readily seized by forceps or a lithotrite and easily extracted.

Fig. 574.



Crusher for large calculus in female bladder.

CHAPTER LXVIII.

DISEASES OF THE BLADDER.

CONGENITAL MALFORMATION.

Extroversion of the Bladder, consisting in an absence of the anterior wall of the organ, with deficiency in the corresponding part of the abdominal parietes, is occasionally met with as a congenital malformation. It may occur in either sex, but is most common in males.

This condition essentially consists in an arrest of development, in consequence of which the anterior part of the pelvic circle is deficient, the bodies of the pubic bones being imperfectly developed and the symphysis being absent. The recti muscles separate at their lower part, and pass obliquely outwards to be inserted into the lateral abutments of the pubic bones. A triangular space is thus left, into which the bladder is forced, and where its anterior wall, being fused with the common integuments, becomes deficient and thus leaves the interior exposed. At this spot also the umbilical cord traverses the abdominal wall, and thus the umbilicus will be found wanting in all these cases, and the urethra to be in a state of *epispadias*. The posterior wall of the bladder, being pushed forwards by the pressure of the abdominal viscera behind, forms a rounded tumor of about the size of a small orange just above the pubes. The surface of this tumor is red, vascular, and papillated, evidently composed of mucous membrane; at its lower aspect the orifices of the ureters will be observed to open, and to discharge the urine in drops or in a stream. For a full description of the mechanism of the passage of the urine in this malformation, I would refer to a case which fell under my notice, and in which I

made a number of experiments on the rapidity of the passage of foreign matters through the kidney, reported in the *Medical Gazette* for 1845.

This malformation is of the most distressing kind. The odor constantly exhaled from the patient by the dribbling of the urine is a source of annoyance to himself and of disgust to others. In order to render his presence at all tolerable to others, this dribbling must be prevented by some mechanical contrivance. With this view the patient should wear a properly constructed instrument to receive and collect the urine, consisting of a hollow shield strapped over the part, communicating by means of a tube with an India-rubber bottle, which may be attached along the inside of the thigh.

Treatment.—Up to a comparatively recent period this condition was considered incurable. Of late years, however, operations have been devised and practised with the view of covering in the exposed bladder, forming an anterior wall to the viscus, and restoring the urinary canal; so as to protect the tender extroverted surface of the bladder, to prevent the pain and irritation arising from contact of the clothes with it, and by a proper conduit to the urine, to save the patient all the annoyance of constant dribbling.

The first operation for the remedy of this malformation that was successfully performed was done, in 1859, by Ayres of New York, in the case of a young woman 28 years of age. He, consequently, has the merit of having been the pioneer in this branch of surgery. He was followed by Pancoast of Philadelphia, and subsequently by Holmes and Wood of London.

[The credit of having performed the first operation for the relief of this deformity is due to Prof. Pancoast of this city, whose case occurred in 1858, the year previous to that of Dr. Ayres. (Gross's *System of Surgery* (2d ed.), vol. ii. p. 722.)—A.]

The operation practised by Ayres comprised two steps. The first consisted in dissecting down a long flap of integument and of superficial fascia from the anterior wall of the abdomen above the bladder, and turning this down so that the cuticular surface was innermost and lay over the exposed bladder as far as its inferior border. Lateral union was then secured in this position, but the lower part of the flap was left open, so as to allow a free exit for the urine. In this way the bladder was covered in completely by a skin-flap, having its cuticular surface underneath, and consequently next to the exposed vesical mucous membrane. The integuments of the abdomen were now sufficiently separated from their areolar connections with the muscles beneath, on each side of the reversed flap, to admit of their sliding forwards, and being united by sutures along the mesial line, so as completely to cover in the exposed raw surface of the flap. In this way the bladder was overlaid by integumental structures, which readily united along the mesial line; and were the patient a male, little more would require to be done than to dissect up the integumental structures below this flap, and so to close in the epispadias and form an anterior wall to the urethra. In Ayres's case, as the patient was a female, the second step of the operation, which was practised after a lapse of three weeks, consisted in fashioning a covering for the vulva, by dissecting up the integuments covering the pelvic bones on each side, and uniting them to one another on the mesial line and to the lower part of the reversed flap. The principle of the operations adopted by Pancoast, Holmes, and Wood is essentially the same as that practised by Ayres—viz., that of raising integumental flaps from the abdominal wall, and covering in the bladder by turning the cuticular surface of these flaps towards it. But the details of the operations differ chiefly in this, that the flaps have been taken from the groins and lateral aspects of the abdominal wall, with their bases downwards, so that they might be nourished by the recurrent branches of the common femoral artery.

CYSTITIS.

Idiopathic inflammation of the bladder is of rare occurrence. This disease most commonly originates either from traumatic causes, as from the passage of instruments, the irritation of broken fragments of calculus, &c.; or it may arise from irritation produced by the application of blisters, the administration of diuretics, or directly from the extension of gonorrhœa to the interior of the organ.

Acute Cystitis.—The *symptoms* of cystitis consist not only in local pain and weight about the hypogastric and iliac regions, with tenderness on pressure in these

situations, and a good deal of constitutional irritation; but in the existence of extreme irritability about the bladder. So soon as a few drops of urine collect, they excite so much irritation in this viscus that they cannot be retained, and are expelled by a kind of spasmodic or convulsive effort, constituting strangury, often accompanied by a good deal of tenesmus and great suffering. The urine will be found to be high colored, mixed with more or less mucus or pus, and often tinged with blood.

Termination.—An acute attack of cystitis usually terminates in the chronic form of the disease, and thus gradually undergoes resolution. Occasionally, however, it terminates fatally; and when this is the case, the patient's symptoms commonly assume an ataxic character, the tongue becoming brown and dry, the pulse rapid and weak, and the urine very offensive. On examination after death, it will commonly be found that the inflammation of the bladder has gone on to gangrene of the mucous membrane, to diffuse peritonitis, or to the formation of abscess, either in the substance of the wall of the bladder or between the bladder and the rectum, with perhaps infiltration of urine in the deep areolar tissue of the pelvis or the perineum.

Treatment.—The treatment of cystitis is very simple, the disease admitting of little being done in the way of medicines. The free application of leeches to the neighborhood of the inflamed organ, long-continued soaking in warm hip-baths, the application of poppy fomentations or of laudanum and linseed-meal poultices, the injection of emollient enemata, and the copious administration of barley-water or mucilaginous drinks, will subdue the inflammation and afford the patient great comfort; to these means may be added the administration of antimonials with henbane or opiates. The only salines that are of much use are the citrate and nitrate of potass; and these must be given largely diluted.

Chronic Cystitis.—Acute cystitis commonly degenerates into the chronic form of the disease, the symptoms of which closely resemble, though in a modified degree, those that have just been described as characterizing acute cystitis, and constitute one of the varieties of the "irritable bladder."

The *treatment* of chronic cystitis must be of a moderately antiphlogistic character, so long as inflammatory action keeps up; when once this subsides, and the disease falls into an asthenic condition, the management of the disease must, to a considerable extent, be modified. In the early stages, whilst there is tenderness and inflammatory action, leeches, warm hip-baths, poppy fomentations, mucilaginous drinks, with henbane, and some alkaline remedies, especially the liquor potassæ largely diluted, will be found most useful, the bowels at the same time being kept open by castor oil and enemata. If there be much strangury of a spasmodic character, it will best be relieved by cupping or leeching the perineum, the internal administration of chloric ether and opiates, or the cannabis indica, and the use of opium suppositories.

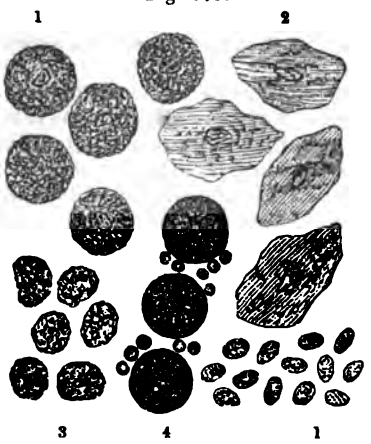
Irritability of the Bladder is a condition of very frequent occurrence. It is met with at all ages, complicates many of the diseases to which the urinary organs are liable, and arises from a great variety of causes.

Symptoms.—The patient has a frequent desire to pass urine; the fluid is generally ejected forcibly, or even spasmodically, and in small quantities at a time. Its passage is attended by pain of a burning, aching, spasmodic character, then constituting *strangury*, sometimes confined to the body, sometimes to the neck of the bladder, not unfrequently extending to the point of the penis, or radiating round the pelvis and down the thighs. The urine may in the earlier stages, and in some cases throughout continue to be healthy; but more commonly, after the disease has lasted some little time, it becomes loaded with mucus, muco-pus, or pus. When the mucoid secretion is abundant, viscid and glutinous, the affection becomes *vesical catarrh*. In this stage its duration may be indefinite, more particularly in individuals advanced in years.

Symptoms of vesical catarrh.—In vesical catarrh the symptoms are made up of local irritation and constitutional debility. There is frequent desire to pass urine, which is usually ammoniacal and fetid, and is mixed with a large quantity of glutinous stringy mucus, which gives it a turbid appearance. The urine, on standing, separates into two parts, the upper being clear, but the lower consisting of a thick, viscid, slimy or gummy mucus, often semi-opaque and purulent in appearance; it

edge in long stringy masses. It is often mixed with urinary deposits, more especially of a phosphatic kind. Its microscopic appearances are represented in Fig. 575.

Fig. 575.



Microscopical appearances in mucus of vesical catarrh: 1, 1. Mucus. 2. Epithelium. 3. Pus. 4. "Organic globules," met with in the urine.

The alkaline condition of urine in vesical catarrh has been supposed to depend upon the fermentative mucus of that disease; but Niemeyer and Lister have shown, that urine mixed with mucus may continue acid for a great length of time, unless it have become mixed with lower organisms, with vibrios, &c., which Niemeyer has supposed to enter the bladder through badly washed catheters, but which, according to Salisbury, are developed directly from the epithelium of that organ.

This chronic form of inflammation of the bladder is not unfrequently fatal, death resulting eventually with symptoms of a typhoid character; the tongue becoming brown and the pulse feeble; and these conditions are usually associated with urinary poisoning of the blood, the mental manifestations becoming dull and obscured, and the body emitting a strongly urinous odor, with a dense clammy sweat.

Pathological changes. — On examining the bladder after death in such cases, great thickening of the muscular coat and of the mucous membrane will usually be found, together with a dilated and tortuous condition of the veins ramifying upon it, the blood contained within which is peculiarly black. Abscesses may be found in the walls or outside them, circumscribed and bounded by plastic matter. The mucous membrane is thrown into folds and ridges, which become thickened and hardened, having irregular depressions between them, so as to cause the interior of the bladder to resemble somewhat the inside of one of the cavities of the heart with its projecting columnæ carneæ. This fasciculated condition is almost an invariable accompaniment of long-continued chronic inflammatory irritation of the bladder. As the organ becomes hypertrophied, in consequence of the continuance of the disease, it usually becomes sacculated, the cysts forming at its posterior or lateral parts. The sacculi are of two kinds, both of which are formed by projections between the fasciculi of the wall of the bladder. In the first and least common kind, the muscular as well as the mucous coat is pushed outwards. In the second form of cyst, the mucous coat alone forms a kind of hernial protrusion (Fig. 576). In the cysts thus formed, accumulations of various kinds may take place: mucus, pus, sabulous matter, and even calculous concretions, not unfrequently being met with in these situations. It is the retention of urine, mixed with mucus or pus in these cysts, where it undergoes decomposition, that is a common cause of the great fetor of the urine in such cases.

Fig. 576.

Cyst in the wall of the bladder.

Causes.—Irritability of the bladder may arise, as has already been stated, from a great variety of causes. These differ somewhat as the disease occurs in men, women, or children. The causes of irritability of the bladder in *men* may be arranged under the following heads:—

1. *Morbid conditions of the urine.*—If this secretion be preternaturally acid and acrid, and loaded with lithates and the products of imperfect assimilation, it is especially apt to occasion an irritation of the bladder, attended by pain and a frequent desire to expel the offending fluid. Urine containing the phosphates and oxalates in large quantity is sometimes, though more rarely, a source of irritability of the bladder, which in these cases is perhaps increased by the morbidly sensitive state of the nervous system usually coexisting with these conditions of the urine.

In *gout*, irritability of the bladder is not unfrequently met with. This appears in some cases to be owing to the acid and acrid character of the urine in that disease;

in other cases, to the excitation of a distinct gouty inflammation of the bladder and prostate, coexisting or alternating with the articular form of the disease.

2. *Renal disease*, more particularly the lodgment of a stone in the kidney, will often occasion sympathetic pains in the bladder, with much irritability of that organ, so as closely to simulate vesical irritability, or even to lead to a suspicion of the existence of stone in the bladder.

3. *Disease of the bladder itself*, as a chronically inflamed state of its mucous membrane, will give rise to pain and irritation on the accumulation of a small quantity of urine in the organ, with a frequent desire for its expulsion. So, also, when the interior of the organ is fasciculated, or contains cysts, and more especially if there be a tumor in a state of ulceration, a degree of morbid irritability will be induced, often of the most severe and intractable kind.

4. The *lodgment of a stone in the bladder* will always, by its mechanical action, by its weight and pressure, by rolling about when the body is in motion, irritate the interior of the organ; and, in fact, the "rational symptoms" of stone in the bladder are simply those of irritability of that organ.

5. *Inflammation, ulceration, abscess, or other diseases of the prostate*, and inflammation, gonorrhœal or simple, and abscess or stricture of the deeper portions of the urethra, may also not unfrequently be referred to as the occasioning causes of irritability of the bladder.

6. *Various diseases in neighboring organs* will occasion this condition. Amongst the most frequent are fissure and ulcer of the rectum and anus, piles, prolapsus, intestinal worms, gall-stones, and varicocele.

Diagnosis.—The diagnosis of irritability of the bladder is easily made; but it is often a matter of no little difficulty, though of the very first importance, to diagnose the precise cause of that irritability. This can of course only be done by a careful *surgical* exploration of the whole of the urinary organs, and often the neighboring parts; no mere inquiry into the nature of the symptoms, no chemical examination of the urine, can do more than establish the fact of the existence of "irritability of the bladder," and afford some evidence of a negative kind as to the absence of certain causes. But nothing short of a careful surgical exploration by means of the catheter, finger, and sound, of the urethra, prostate, and bladder, can enable the practitioner to state with absolute certainty on what this condition of irritability depends. I have repeatedly seen cases of stone in the bladder, and of prostatic disease, vainly treated by medical means for months as cases of simple "irritability of the bladder;" the existence of the real cause of the symptoms having been overlooked altogether, until a proper surgical examination of the urinary organs was instituted. So closely, in fact, do the symptoms of vesical irritation, arising from gout or sympathetic with kidney-disease, simulate those that are occasioned by stone in the bladder, that it is impossible for the most experienced medical practitioner to refer them with certainty to the right cause without exploring this cavity. And, indeed, I have known several patients who had been successfully operated on for stone, and who, some years afterwards, suffered from gouty or other irritability of the bladder, imagine, but erroneously, that they were laboring under a recurrence of the calculus; so closely do the two classes of symptoms coincide in character.

Treatment.—The treatment of irritability of the bladder must have reference to the removal of its cause, and the subdual of the local irritation, by the use of demulcents and soothing means. It must be borne in mind that this condition is not a substantive disease, but is an assemblage of symptoms resulting from the influence of a great number of very various causes, which must first be removed before the bladder can recover its normal sensibility and tone. When once the occasioning cause has been removed, whether that be a calculus, or gout, or prostatic disease, or a pile, the remaining local vesical irritation may usually be removed by the assiduous use of weak alkaline and mucilaginous drinks, with henbane, cannabis indica, or opiates, a carefully regulated diet, warm hip-baths, and opiate suppositories in the rectum.

[I have occasionally derived much benefit in these cases from the application of a belladonna plaster, above the pubes.—A.]

Treatment of vesical catarrh.—When vesical catarrh has come on, and the disease has lost its active inflammatory character, appearing rather to consist of atonic exudation from the mucous membrane, a different plan of treatment will require to be adopted. In such cases as these, the greatest benefit will be derived

buchu or matico in large doses. These remedies are useless, unless taken in quantities of a pint or a pint and a half in the day. They may be conjoined with nitric acid and tincture of nux vomica, if the urine be alkaline and the bladder atonic. But no remedy appears to me to possess so much influence over the mere ropy mucoid discharge as the balsam of copaiba. Turpentine, cubebs, and tincture of the sesquichloride of iron, will be found useful. It is often difficult to say beforehand which diuretic will suit best, and I can lay down no precise rules to guide the practitioner in this respect. But they may often be tried or alternated with advantage. In many cases great temporary relief is obtained from each new remedy, which fails to be maintained. In the more advanced forms of the disease, when typhoid symptoms come on, bark and ammonia will be found most useful, together with the administration of the brandy-and-egg mixture. In these cases also it is of great importance to empty the bladder, by means of the catheter, of the viscid mucus that accumulates in it, and the putrefaction of which, together with that of the residual urine, tends to engender the depressed state into which the patient sinks. In some cases, this may advantageously be done by washing it out with warm water injections through a double-current catheter. In this stage of the disease, benefit may occasionally be derived from the employment of very slightly astringent injections. Amongst the most useful of these will be found the nitrate of silver, in the proportion of one grain to four or six ounces of tepid distilled water. Brodie has advantageously employed water very slightly acidulated with nitric acid.

Irritability of the Bladder in Children appears to be an affection closely allied to the congestive and subacute inflammatory conditions of the different mucous membranes, as of the eyes, nose, and throat, that commonly occur in strumous subjects. In this disease the child passes urine with great frequency and with much pain; the urine is offensive, and usually phosphatic; not unfrequently there is much uneasiness complained of about the groins and along the penis; in fact, many of the ordinary symptoms of stone are present. On sounding the bladder, it will be found roughened, fasciculated, and often containing sabulous matters mixed with mucus. Occasionally there is a good deal of gastro-intestinal irritation, and not unfrequently worms are present.

The *treatment* should consist in attention to the general improvement of the health of the patient, in the removal of intestinal irritation, in the regulation of the digestive functions, and in the administration of copaiba in small doses, either alone or conjoined with a few minims of liquor potassæ, at the same time that general antistrumous treatment must be properly carried out.

Irritability of the Bladder in Women not unfrequently occurs, and often simulates stone so closely, that it is only after very careful sounding that the surgeon is satisfied that no calculus exists. This condition appears to be dependent on a morbidly sensitive state of the mucous membrane of the urethra and bladder, that may arise from a variety of causes. In some cases it is a truly neurotic or hysterical condition. In other instances it is sympathetic: being connected with some local disease of the genito-urinary organs, with a vascular tumor at the meatus of the urethra, or with some congestive affection of the uterus, which will require to be cured before the bladder can be brought into a sound state. Prolapsus of the anterior wall of the vagina, drawing down the corresponding portion of the bladder, will keep up this condition; if so, the prolapsus must be cured by some plastic operative procedure. In all circumstances, however, when this state has once been set up, it is very difficult to remove. In many cases it is undoubtedly due to the irritation produced by a morbid state of the urine, dependent on mal-assimilation, and usually connected with an excess of lithates. In cases of this kind, careful regulation of diet, and the administration of potass with henbane or copaiba, will afford much relief; but the complaint is of a very chronic and intractable nature, and under the most careful treatment will often continue for years.

TUMORS OF THE BLADDER: AND HÆMATURIA.

Polypi and **Fungous Growths** are occasionally met with in the bladder, flat, pedunculated, or pyriform in shape. *Polypi* of the bladder may be composed of various elements; sometimes, but rarely, fibrous, at others villous; they may occur at all ages, and usually give rise to a certain degree of irritation in this organ, which

is especially marked when they occur in the vicinity of its neck, where they may even cause retention of urine, and some of the symptoms of stone. *Fungous growths* most commonly are of a malignant character, fibro-plastic, epithelial, or encephaloid; they then give rise to bloody urine, in which cancer-cells and *débris* may be found on microscopic examination, thus serving as a diagnostic mark of the nature of the disease.

Malignant fungus or cancer of the bladder is usually associated with similar diseases of the prostate or neighboring structures, and in women may be secondary to cancer of the uterus. According to Walshe, it does not appear before the fortieth year.

These tumors, whether simple or malignant, occasionally become incrusted with *phosphatic* matter, deposited upon them by the urine; and then they will resemble still more closely a calculus when the bladder is sounded; from it, however, they may be distinguished by their fixed character, and by the impossibility of passing a sound around them. Some difficulty is often experienced in examining the bladder in these cases; for, as the fungous mass pushes back the posterior wall of the viscus, it has a tendency to elongate the prostatic portion of the urethra and the neck of the bladder, so that a very long instrument may be required to reach it.

Little can in general be done in the way of *treatment* in this disease; though the example of Civiale might, in some cases, be advantageously followed, who removed a small growth seated at the neck of the bladder by seizing and twisting it off with a lithotrite. Warner has recorded a case in which a tumor of this kind, of the size of an egg, was tied in the bladder of a woman after dilating her urethra.

Hæmaturia.—The admixture of blood with the urine may usually be recognized by the color that it communicates to this fluid. If the blood be in large quantities, the urine will be dark brown, chocolate, or maroon-colored, and will stain red the bottom of the utensil or a piece of white blotting-paper. If it be in smaller quantities, the urine will be brown; and in other cases it will be little discolored, but will deposit a red or brown sediment on standing. Heat coagulates the blood into a brownish-gray deposit, leaving a clear supernatant fluid; and, under the microscope, blood-disks may be detected in large quantities.

Hæmaturia is a symptom of disease existing in some part of the urinary apparatus; but it often assumes so great an importance from the loss of blood induced, that it must be looked upon as a substantive disease.

Sources.—Hæmaturia may arise from 1, the kidneys; 2, the bladder; 3, the prostate; or, 4, the urethra; and from each source several distinct causes will produce it. The recognition of the precise morbid condition that gives rise to hæmaturia is of the first importance in its treatment.

1. *Hemorrhage from the kidneys.*—When occurring from the kidneys, the bleeding may be the result of congestion of those organs, of the presence of a calculus in them, or of its descent down the ureter, or of malignant disease. The renal congestion may be inflammatory or passive; in either case the urine will present, after the discharge of blood has ceased, evidences of chronic renal disease in the form of albumen, pus, or casts of tubes. When the hemorrhage arises from renal calculus, either stationary or descending, the symptoms of that morbid condition, described in p. 1031, will be well marked.

2. *Hemorrhage from the bladder.*—If the blood proceed from the bladder, it may be the result of congestion of the mucous membrane, of the irritation of a calculus, or of the ulceration of malignant disease. When it depends on vesical congestion, there will be a sensation of weight in the region of the bladder, with frequent desire to pass urine; when on calculus, the special symptoms of the existence of stone will be present; and when on malignant disease, the discharge of pus, and of the *débris* of the ulcerating tumor, will afford unequivocal evidences of the true source of the hemorrhage.

3. *Hemorrhage from the prostate.*—If the prostate be the source of hemorrhage, the discharge may be occasioned by congestion of that organ, or by its ulceration, simple or malignant. In these cases, exploration by the rectum and urethra will indicate the true cause of the bleeding.

In general, when the hæmaturia is renal, the urine will be uniformly mixed with the blood; when it is prostatic or vesical, the first urine that passes, or that is drawn off by the catheter, will be pale and less bloody than the last; and at the termination of the flow nothing but blood may escape.

4. *Hemorrhage from the urethra.*—The bleeding may arise from simple congestion of the mucous membrane, from inflammatory irritation of it, or may follow rupture of the walls of the canal, consequent on injury or on the introduction of instruments.

[Much information may be gained by floating out in water all clots from the urinary passages; in this way Mr. Hilton has been able to recognize clots which from their shape had evidently been formed in the pelvis of the kidney, the ureters, etc. (*Guy's Hosp. Reports*, 3d s., vol. xiii. pp. 19–28.)—A.]

Treatment.—The treatment of hæmaturia must necessarily have reference to its cause. If it arise from inflammatory congestion of the kidneys, bladder, or prostate, cupping, or the application of leeches over the affected part, demulcents, and saline drinks, will be most efficacious; if from passive congestion, it will usually be found that the hepatic portal system is at fault, and a dose or two of blue-pill or calomel, followed by a purgative, and afterwards by the use of astringents, will speedily induce a cessation of the hemorrhage. The astringent that exercises the most marked influence in arresting hæmaturia, when that condition is purely passive, is undoubtedly gallic acid. This may be given in five or ten grain doses, frequently repeated, in infusion of buchu or uva ursi.

As a general rule, it is better not to use the catheter in these cases; but sometimes the bladder becomes distended by a large soft coagulum, filling up its interior, and causing it to reach to the umbilicus, forming a rounded solid tumor, like a gravid uterus. In such circumstances, the more fluid contents may be drawn off by a large catheter, and the more solid portions broken down and washed away by the injection of tepid water through a large-eyed or double-current catheter. If decomposition occur in the coagulum, giving rise to the formation of flatus in the bladder, a weak tepid saline solution, to which a little creasote has been added, may advantageously be used. I have known abundant hæmaturia to continue for many years —for twelve or fourteen—without any very evident cause, and without deranging the general health to so great an extent as might be expected from so continuous and copious a loss of blood.

[Cases of *intermittent*, or more correctly *paroxysmal hæmaturia*, have been recorded by several authors. The condition does not appear to be fatal, and the best treatment consists in the administration of tonics, particularly iron and quinine. (Greenhow, in *Trans. Clinical Society*, vol. i. pp. 40–57.)—A.]

ATONY OF THE BLADDER.

Atony of the bladder may occur with the opposite conditions of retention and incontinence of urine, according as the neck of the organ retains or has lost its contractile power. When the body of the bladder is paralyzed, whilst the neck preserves its contractility, retention of urine will ensue in consequence of simple inability on the part of the organ to expel its contents, and not from the existence of any mechanical obstacle to the outward flow of the urine. When, on the other hand, the neck of the bladder is paralyzed, the urine cannot be retained, but dribbles away involuntarily, thus constituting incontinence.

[*Incontinence* is, however, as shown by Thompson, in the large majority of cases an indication of a distended bladder, and should properly be termed *overflow*.—A.]

Retention of Urine.—Loss of tone in the body of the bladder, leading eventually to its paralysis, not unfrequently occurs in old age as the result of simple diminution of muscular power; or it may happen as a consequence of fever; or as one of the symptoms of paraplegia, from whatever cause arising. It may occur suddenly in cases of injury, in which the lower part of the spinal cord is paralyzed.

Symptoms.—When this condition comes on slowly as the result of disease, the patient usually finds that the urine escapes in a dribbling manner; that there is some difficulty, and at last an impossibility, in emptying the bladder completely; and there is not that forcible ejection of the last drops of urine that is characteristic of a healthy tone in the organ; at the same time there is not unfrequently a tendency to the dribbling away of a few drops towards the end of the emission of urine, and after its apparent cessation. There is also an occasional escape of urine at night. When complete retention occurs, whether this take place gradually or suddenly, the bladder slowly enlarges, rising at last out of the pelvis into the abdomen, stretching up into the hypogastric region, reaching even as high as the umbilicus.

On examining the lower part of the abdomen, the organ will be felt hard, elastic, rounded, and pyriform in shape, projecting above the pubes, and feeling much like an enlarged uterus. In this situation, also, percussion will elicit a dull sound; and on exploring the part through the rectum, the bladder will be found to project in this direction also; and on tapping with the fingers above the pubes, fluctuation may be felt through the wall of the gut. After the bladder has once become distended, it commonly happens that a quantity of urine continues to dribble out of it; in fact, the amount that escapes in this manner may be very considerable, though the retention continue unrelieved. This *retention with dribbling* is a condition of much practical importance, as the continued escape of urine may lead the patient, and even the surgeon, to overlook the true nature of the disease; the more so, as in elderly people retention slowly induced often occasions but little inconvenience. I have drawn off nearly a gallon of urine from a patient in whom it had not been suspected that retention existed, in consequence of the continuance of this dribbling. In women, retention is not by any means so common as in men, but the bladder will sometimes attain an enormous size, rising as high as the umbilicus; and such large bladders have been tapped under the supposition of the tumor being an ovarian cyst, or some similar growth. I once witnessed such a case in which the surgeon, to his surprise, on tapping the tumor, drew off a quantity of clear and healthy urine instead of ovarian fluid; fortunately no bad effects followed. This retention with dribbling occurs in consequence of the bladder, as it rises out of the pelvis, elongating its neck; and as the body becomes bent forward over the pubes a sharp curve or angle is formed at the junction of the neck and body of the viscus, through which a small body of urine continues to dribble away, and escapes rather by its own gravity than by any expulsive effort on the part of the patient.

Diagnosis.—Retention from atony can easily be diagnosed from *retention from obstruction:* for, on introducing the catheter when the patient is lying on his back, the instrument will not only readily enter, but the urine will simply flow in a slow uniform stream, not being projected in a jet by the contraction of the walls of the organ, but rising and falling in obedience to the respiratory movements. The urine that escapes in a case of retention will always be found to be high-colored and very ammoniacal; its specific gravity is also considerably increased, in consequence probably of the absorption of its more watery constituents.

Results.—The habitual retention of a small quantity of urine in an atonic bladder which is incapable of discharging completely the whole of its contents occurs much more frequently than is suspected. The quantity thus retained will vary from an ounce to half a pint: the patient believing that he has emptied his bladder, but the introduction of a catheter proving the existence of retained urine. This condition will be a source of serious inconvenience, and eventually of disease, to the patient. In consequence of the bladder never being completely emptied, there will be frequent, sudden, and almost irresistible calls to pass urine, so as to simulate irritability of the bladder. The retained urine becomes offensive, ammoniacal or fishy in odor, and mixed with mucus or muco-pus. The constituents of the urine become absorbed, give rise to impaired nutrition, and, being eliminated by the skin, irritate it and occasion intractable forms of skin-disease. I have seen chronic eczema of the most inveterate character produced in this way, and only yield to treatment on care being taken to keep the bladder clear and free from residual urine. The continuance of complete retention of urine from paralysis or atony of the bladder, will probably give rise to fatal consequences; a subacute inflammation taking place in the mucous membrane of the organ, which falls into a sloughy condition, accompanied by symptoms of a typhoid type. In some instances coma supervenes, owing to the poisoning of the system by the absorption of the urinary constituents. Even though the retention be relieved, this condition is apt to come on; vesical catarrh with fetid urine supervening, the tongue becoming brown, and low fever setting in. It is very seldom that the bladder ulcerates or bursts when the retention arises from paralysis of that organ independent of any mechanical obstacle; the continued dribbling preventing this consequence.

Treatment.—The treatment of this form of retention must have reference to the cause of the atony or paralysis of the bladder; but in all circumstances the urine must be drawn off regularly. A large gum catheter must accordingly be introduced twice a day, even though the retention be not complete, in order to empty the bladder of the small quantity of residual urine left in it after the apparent evacu-

ation of its contents; and, in doing this, care must be taken that the beak of the instrument properly enters the body of the bladder, which is further removed from the pubes than usual; for it will sometimes happen that it may enter the dilated prostatic part of the urethra, or elongated neck of the bladder, when, an ounce or two of urine escaping, it may be supposed that there is no more left, though in reality the viscus is immensely distended. In order to get the catheter well in, its point should be closely hooked around the pubes and raised by depressing the handle between the thighs. In cases of paralysis, the catheter should not be allowed to remain in the bladder, lest the pressure of its point against the mucous membrane increase the tendency to low cystitis, or give rise to sloughing.

If the retention arise from paralysis dependent on injury or disease of the spine, it will occasionally be found that strychnine, either administered internally or applied endermically, will tend to lessen it. If the atony arise from old age, the administration of cantharides, or the application of a blister to the sacrum, may be of use. In some cases the application of cold to the inside of the thighs or to the abdomen will facilitate the contraction of the organ; hence it is to the custom of some old men laboring under this affection to press the chamber utensil against the inside of the thighs; and I have known a patient find more relief from sitting on the marble top of his commode, than in any other way.

Incontinence of Urine arises from weakness of the neck of the bladder, in consequence of which there is not sufficient power to hold the contents of the organ, and the urine escapes. It may be regarded as active or passive, according as the body of the bladder retains or has lost its contractile power.

Active incontinence is most frequent in children, in whom it occurs during sleep, the patient losing command over the sphincter so soon as a small quantity of urine has accumulated behind it. In many cases it is sympathetic, dependent on the irritation of piles, stricture of the urethra, or stone in the bladder; and occasionally it results from nervous causes, more particularly in women of a hysterical temperament. In strumous children, nocturnal incontinence of urine is very apt to occur; probably from the irritation produced by the fluid, which is generally found loaded with uric acid crystals.

Passive incontinence, or, as it has been termed by Thompson, *overflow* of urine, occurs when the bladder is in a state of atony. In such cases, the sphincter-like action of the neck may not be quite lost, so that a small quantity of urine is ejected from time to time, as it overcomes the slight resistance offered by the partial contractility of the neck. Over-distension of the bladder will occasion incontinence of urine, not from paralysis, but from a kind of strain of the muscular structures of the part: in this way a patient, who from circumstances has been unable to empty his bladder for a considerable time, may suffer from incontinence. Incontinence or overflow is also liable to occur in cases of enlarged prostate; being here preceded by distension (see page 1100). In old people it may occur from simple debility, and is commonly associated with a tendency to retention.

Treatment.—The treatment must depend upon the cause. When the incontinence occurs in weakly children, if it be not connected with worms or gastro-intestinal irritation, which should then be removed, the administration of tonics will be found useful—either quinine or the tincture of sesquichloride of iron, alone or conjoined with tincture of cantharides. If there be irritation of the mucous membrane of the bladder, the administration of alkalies, in conjunction with a tonic, as the potassio-tartrate of iron, or a little copaiba mixed with honey, will be found very serviceable. Cold sponging, light clothing at night, and means calculated to break the habit, such as waking the child at the time at which it generally occurs, changing his position in bed, &c., should not be omitted. When it occurs at a more advanced period of life, if there be any source of sympathetic irritation, this must be removed: if none can be discovered, recourse must be had to tonics, especially iron and lytta with strychnine, and galvanism, together with cold douching or shower-baths.

[The internal exhibition of belladonna, or the hypodermic use of atropia is often serviceable in cases of nocturnal incontinence in children. In cases of adults it should never be forgotten that incontinence (so-called) is, usually, really overflow from a distended bladder, and that the first step of the treatment should therefore be the use of the catheter. In these cases the patient's water should be drawn off very gradually, and while the patient keeps a recumbent position, as from the sudden

diminution of pressure, syncope may occur, just as in the operation of tapping the abdomen.—A.]

Hysterical retention and incontinence of urine not unfrequently occur in nervous girls, and require to be treated by antihysterical remedies, amongst which preparations of sesquichloride of iron, either alone or with valerian, will be found most useful. Cold douches are also of great service. In cases of hysterical retention, it may sometimes be necessary to use the catheter; but in such circumstances it is well not to employ this instrument too frequently, as the patients are apt to get into the habit of having it introduced, and will, with that morbid propensity that characterizes hysteria, continue for a length of time to require its introduction. If left to themselves, though the bladder may become much distended, it will not burst, but will probably empty itself without further trouble, particularly if the patient be put in a tub and well douched over the hip and loins with cold water. In some cases, these morbid conditions in women appear to be connected with some local irritation about the urethra or uterus; and then proper treatment must be directed to these organs before the disease can be removed.

Painful Conditions of the Bladder.—The bladder is often the seat of severe pain, either continuous or remittent, without any disease being discernible in it on the closest examination; the pain being either a kind of neuralgic condition, especially occurring in hysterical or hypochondriacal patients; or else being sympathetic with, and dependent on, disease at a distance, as in the kidneys, uterus, rectum, &c. At the same time it must be borne in mind, that the secretion of acid or irritating urine will, in some individuals, be a source of much and constant suffering; and that any disease seated about, or coming into contact with, the neck of the bladder, as tumor, stone, &c., is especially apt to give rise to severe suffering, and will, in many cases, be accompanied by frequent desire to micturate, with much spasm about the part.

CHAPTER LXIX.

DISEASES OF THE PROSTATE.

The prostate is subject to acute and chronic inflammation, to hypertrophy, and occasionally to atrophy, malignant disease, tubercle, and the formation of calculi.

PROSTATITIS.

Acute Inflammation of the Prostate, or Prostatitis, very rarely occurs as an idiopathic affection. When met with, it is usually the result of gonorrhœa, or of the use of stricture-instruments, more especially in middle-aged men.

Symptoms.—These are deeply seated dull pain, with heat and weight in the perineum, a frequent desire to pass urine, and very great and spasmodic pain accompanying the act; in fact, the irritability that is set up about the neck of the bladder is perhaps the most marked and distressing feature in the disease. These symptoms are, however, common to various inflammatory affections of the urinary organs, and they can only be distinctly referred to the inflamed prostate by rectal exploration. On introducing the finger into the gut, the prostate will be found much enlarged and exquisitely tender to the touch; and the patient often suffers considerably from the pressure of the inflamed organ upon the rectum during defecation.

Treatment.—This should be of an active antiphlogistic character, so as to prevent, if possible, the formation of abscess. The perineum must be cupped or well leeched; warm hip-baths and poppy fomentations assiduously employed; and salines with antimony administered. In this way, the formation of abscess within or around the prostate may, in many cases, be prevented.

Prostatic Abscess may happen either as a consequence of acute inflammation running into the suppurative stage, and in this way it is not very unfrequently met with as a complication of gonorrhœa; or it may occur with comparatively little

antecedent inflammation—as sometimes happens in pyæmia, or if the organ be accidentally bruised during lithotrity. In these cases, abscess perhaps as frequently forms in the areolar envelope as in the organ itself. Idiopathic suppuration of the prostate, irrespective of any of the above causes, is, however, of rare occurrence; but it may occur in individuals of broken health, the matter then usually accumulating in large quantity, and discharging itself into the bladder.

Symptoms.—When inflammation of the prostate terminates in abscess, rigors, with strangury, and perhaps retention of urine, occur. In many cases the perineum becomes brawny; in others, tenderness of the gland and deep fluctuation may be felt through the rectum. When left to itself, the abscess most usually gives way into the urethra or neck of the bladder; but it may, especially when occurring in the prostatic capsule, open externally into the perineum, or even into the rectum. In many cases, the abscess presenting on the urethral surface of the prostate is burst during the introduction of the catheter, used for the relief of the retention of urine induced by the pressure of the tumefaction; the matter escaping along the side of and through the instrument.

Treatment.—It not unfrequently happens that the first certain indication afforded to the surgeon of the formation of a prostatic abscess is the escape of pus by the urethra, or mixed with the urine, so as to give this fluid a thick milky appearance. In such circumstances, the only available treatment is that which is directed for the relief of the strangury and local vesical irritation on ordinary medical principles, such as have already been described. But if, as sometimes happens, the pus come forwards into the perineum, then a more decided line of treatment is required. In these cases a hard brawny mass will be felt lying deeply on the side of the perineum; and into this a deep incision should be made. The surgeon must not wait for fluctuation, but must cut deeply in the direction of the matter, keeping, however, as nearly as possible in the mesial line, with the back of the knife towards the rectum. Even if no pus escape at first, it may do so if the part be well poulticed for a few hours; and thus communication with the urethra or rectum may be prevented.

Retention of Urine from Prostatitis.—In prostatitis, retention may occur from the swelling of the organ, from the infiltration of exudation-matters around it, or from the formation of pus in it. In these cases the neck of the bladder will be carried to a considerable distance from the surface, and may very probably not be reached by an ordinary catheter, which may be buried up to the rings and yet not enter the cavity of that organ. In these circumstances a silver prostate-catheter should be employed; and this must be carefully introduced, lest, by entering the cavity of an abscess which has already burst *per urethram*, it might be supposed to have entered the bladder itself. In introducing the instrument under these circumstances, care should be taken to keep its point constantly in contact with the upper surface of the urethra, and to hook it round the pubes. The *upper* surface of the urethra is a sure guide to the bladder; for any abscess, false passage, or irregularity of direction will always first affect the lower aspect of this canal, being surrounded by yielding structures; whilst the upper part, being firmly supported by bone and ligament, cannot so readily alter its direction.

CHRONIC ENLARGEMENT OF THE PROSTATE.

Chronic enlargement of the prostate may be looked upon as a senile disease, seldom occurring before the age of fifty-five, and being commonly met with after this. At that period of life, as Brodie observes, when the hair becomes gray and scanty, when atheroma begins to be deposited in the coats of the arteries, and when the arcus senilis forms on the cornea, the prostate often becomes increased in size. At the same time, however, other changes take place in the genito-urinary system; thus the urethra becomes dilated and the bladder thickened; and, unless the enlargement of the prostate advance in too great a proportion to the other changes, so as to interfere with the free escape of the urine, no disease can properly be said to be established. If we look upon the diseased enlargement of the prostate as such an amount of hypertrophy of this organ as interferes seriously with the discharge of the urine, we shall probably not find it so frequent even in old men as is generally supposed. Guthrie states that it is not commonly found in the pensioners at Greenwich Hospital. Thompson found that an enlargement appreciable after death existed in 34 per cent. of men above the age of sixty; but that such a degree of

enlargement as to give rise to symptoms during life was only met with in 15 or 16 per cent. of the cases he examined. Though age must be looked upon as the primary cause of this particular hypertrophy of the prostate, there can be little doubt that it may be predisposed to by any continued source of irritation of the urinary organs, such as gonorrhœa, stricture, or hard living.

Characters.—Enlargement of the prostate is due to hypertrophy of the normal structures—fibrous and glandular—of the organ. Most commonly there is an excess of development of the fibrous structure; generally, however, when the size of the gland has been very slowly and not greatly enlarged, there is nearly equal hypertrophy of all the tissues. In rare instances, there is excessive development of the glandular element; and in some cases homologous tumors are developed. The enlargement generally occupies the whole of the organ, and may cause its size to increase to that of a hen's egg or a small orange; in most cases, all the lobes are enlarged equally or nearly so, but sometimes there is a greater development of one of the lateral lobes or of the middle portion. More rarely, the lateral lobes or the anterior commissure alone are enlarged.

The enlarged prostate, in the earlier stages, presents to the naked eye an appearance of rotundity and increased fulness: at a more advanced stage, there may be great irregularity of outline. There is usually no change of color externally: and the texture of the gland is generally indurated, though sometimes it is found to be looser and softer than natural. On making a section, the cut surface bulges above the level; and the shades of color are more strongly marked than in the healthy prostate. Not uncommonly, single gland-lobules are found hypertrophied; and in some cases, spheroidal prominences are seen, which are easily enucleated, and which are tumors formed in the substance of the gland. These we shall presently speak of. In some instances, an abundance of fluid escapes from the cut surface and from the openings of the prostatic ducts; while in other cases this is entirely wanting. Small cavities, dilatations of the gland-follicles, are occasionally found; sometimes empty, and sometimes containing a yellow fluid resembling pus in appearance, but which consists of the prostatic secretion in a thickened state.

Simple Prostatic Tumors.—The nature of simple tumors of the prostate has been carefully studied by Sir Henry Thompson; to whose elaborate work on the diseases of this organ the student is referred for further information. According to Thompson, tumors of non-malignant character are met with in most cases of hypertrophied prostate, and also occasionally when there is no enlargement of the organ. He divides them into two classes.

"1. Tumors which are generally imbedded in the substance of the prostate, but the structures of which are isolated from those which surround it.

"2. Outgrowths which are continuous in structure with the parts of the prostate whence they spring, but which manifest a tendency to become partially isolated, by assuming a more or less polypoid form, and maintaining attachment to the parent organ through the medium of a pedicle only."

1. The *isolated tumors* in the substance of the prostate have been recognized by Sir E. Home, Cruveilhier, Rokitansky, Paget, and other pathologists. They may occupy any portion of the organ; but are, perhaps, more numerous in the lateral lobes than elsewhere. They are easily enucleated, having but a loose connection with the substance of the gland. In diameter they vary from $\frac{1}{10}$th to $\frac{3}{8}$ths of an inch. They are firmer and mostly paler in color than the proper prostatic tissue, and are less vascular.

"The basis of the tumors appears to be the fibrous basis or stroma of the prostate itself, an admixture of unstriped, soft, pale muscular fibres, and connective with a little elastic tissue, closely interwoven. Interspersed with this, there are present in most cases small cavities containing flattened polygonal or spheroidal epithelium, like that seen in a pouch at the extremity of a prostatic gland-duct, and sometimes, also, some prismatic epithelium. These cavities are sometimes solitary, sometimes slightly branched, and sometimes of an elongated or tubular form. In a few instances there is very little, or, perhaps, no such glandular tissue to be found; generally, however, a careful search will discover it. In some of the outlying tumors the glandular structure is more perfectly developed—in some it is quite so—and a duct is furnished which evidently carries secretion to the appointed destination."

2. The part of the prostate which is most usually the seat of *outgrowth* is the middle or urethral portion, which may become greatly enlarged in size, with or

and is more or less pedunculated. It is continuous in structure with the prostatic tissues, and has its own duct, which opens into the urethra through the pedicle. Prostatic concretions are commonly found in these outgrowths; never in the isolated tumors.

Outgrowths are most common in the middle portion of the prostate; but sometimes there may be a projection from the posterior part of one of the lateral lobes, or from that portion of the gland which lies above or in front of the inner orifice of the urethra.

In rare instances, the verumontanum alone appears to be affected, forming a thickened polypoid projection, which projects in a valvular manner, and interferes materially with the flow of urine.

Thompson points out, as had been suggested by Velpeau, that remarkable analogies exist between these prostatic outgrowths and the fibroid tumors of the uterus. This view is in accordance with the teaching of Leuckart, Simpson, and others, that the prostatic utricle in the male is the analogue of the uterus in the female.

Mechanical Effects of Enlarged Prostate on the Urinary Organs.—Enlargements of the prostate are productive of inconvenience with regard to the flow of urine, giving rise either to retention or to incontinence, or to a kind of mixture of both conditions. When the lateral lobes are enlarged, there is a diminution of the lateral or transverse diameter of the canal, at the same time that the antero-posterior diameter is increased, so that the canal becomes a chink-like passage. The urethra also becomes greatly elongated and tortuous; and is diverted from the natural direction—this varying with the form of enlargement. When the median portion is enlarged, there is a more or less angular curvature of the canal at the prostatic portion. When, in addition, there is enlargement of a lateral lobe, the urethra is also curved laterally in the direction of the enlarged lobe. The lateral deviation may occur also when there is enlargement of the middle lobe; but it then affects both sides.

The inner orifice of the urethra also undergoes changes. Enlargement of the posterior part of the middle portion of the prostate giving it a crescentic form, with the convexity directed upwards; and, in enlargement of either lateral lobe, the convexity of the crescent lies towards the side opposite the enlarged lobe. Sometimes, when there are two or more irregularly enlarged lobes, the orifice is very much distorted, elongated, and tortuous. Sometimes, in cases of valvular or pedunculated projections from the posterior portions, the orifice appears to be overlapped altogether. This condition existed in the case from which the accompanying figure (Fig. 577) was taken; the third or median lobe forming a pedunculated tumor which acted like a valve—obstructing the exit of the urine from the bladder, though it did not offer any obstacle to the introduction of a catheter.

Fig. 577.

Enlargement of urethral portion of prostate.

The elongation and expansion of the prostatic portion of the urethra gives rise to an increase of its capacity, so that it sometimes holds two or three ounces of urine; and the elongation will carry the neck of the bladder upwards and behind the pubes, to a considerable distance from the urethra.

While the lateral enlargements cause the urethra to assume a somewhat tortuous course, the middle lobe, if hypertrophied, may readily occasion retention, by projecting against the entrance to this winding channel, and falling over it like a valve whenever the patient attempts to pass urine, as in Fig. 577. Then, again, if the middle lobe continue small whilst the enlargement of the lateral lobes takes a direction up towards the bladder, widening as they go, the vesical neck may be so dilated that incontinence and a continuous dribbling will occur through a kind of fissure that extends between the lateral lobes.

The obstacle offered to the passage of the urine by an enlarged prostate will usually eventually give rise to a chronically thickened, fasciculated, and sacculated

bladder, the fundus of which descends below and behind the enlarged gland, forming a kind of pouch that cannot empty itself, and in which mucus and morbid concretions are apt to collect. The ureters often become dilated and the kidneys chronically diseased; a series of changes well illustrated by the annexed cut (Fig. 578).

Fig. 578.

Results of enlarged prostate: Bladder thickened and enlarged; ureters dilated; chronic disease of kidneys.

Symptoms.—The symptoms of enlarged prostate arise primarily from the mechanical obstacle offered to the escape of the urine. The first symptoms usually consist in the feeling of a necessity to strain slightly before the urine will flow; and then, after the bladder has been apparently emptied, in the involuntary escape of a small quantity of urine. The patient also finds that he is much longer than usual in emptying the bladder; for, though the stream flows freely enough so soon as it has once begun to escape, yet it cannot be properly projected, the viscus having, to a certain extent, lost its tonicity. About this time changes begin to take place in the urine, which usually becomes somewhat fetid, even while it continues acid, and is often intermixed with more or less viscid, stringy mucus; though in many cases it is clear, pale, and not in any way altered in character. The symptoms often come on in a very gradual manner, the patient straining and experiencing much difficulty in the extrusion of the urine for months or even years before retention will occur. As the disease advances and the bladder becomes less capable of emptying itself, two or three ounces or more of residual matter are left, which becomes dark, and mixed with adhesive sticky mucus; and, at last, if the mucous membrane of the bladder fall into a chronic state of inflammation, it assumes a milky appearance from an admixture of pus, and becomes horribly offensive, blackening the silver catheter.

Diagnosis.—The exact condition of the enlarged prostate can only be ascertained by examination through the rectum and urethra. By rectal exploration with the finger, the degree of enlargement of the lateral lobes can best be ascertained; though, as in many cases the end of the finger cannot reach the further extremity of the gland, it will be impossible to say to what extent the hypertrophy has extended. The urethral exploration must be conducted by means of a long gum-elastic or a silver prostatic catheter, and will afford information that rectal exploration cannot give; and by it are ascertained approximately the size of the middle lobe, and the condition of the urethra as to elongation and curve.

The diagnosis of obstruction in consequence of enlarged prostate has to be made from that produced by 1, stricture of the urethra; 2, calculus of the bladder; 3, vesical tumor; 4, chronic cystitis; 5, atony of the bladder; 6, paralysis of the bladder.

1. In *stricture* the stream of urine is small; the obstruction is within six inches of the meatus; and the disease mostly occurs before middle life. In enlarged prostate, the flow of urine is not always reduced in volume; the obstruction is at least seven inches from the orifice; and the enlargement does not occur until after middle life.

[In *stricture* the stream though small may be propelled with as much force as in health, and may even describe the ordinary parabolic curve: in *enlarged prostate*, on the other hand, the stream, though possibly of considerable size, tends to drop vertically from the meatus. In the latter case, the propulsive power of the bladder is lessened, while a stricture, diminishing the calibre of the discharging tube, would rather tend to augment the force of the current.—A.]

2. *Calculus* presents many symptoms in common with enlarged prostate, and its more special symptoms may be absent. The presence of a small quantity of

florid blood in the urine passed after exercise should make the surgeon strongly suspect the presence of a stone; but the use of the sound will alone lead to an exact diagnosis.

3. *Vesical tumor* gives rise to more pain and tenderness on the introduction of instruments than prostatic enlargement; and the urine generally contains sanious discharge and flocculi, often with sabulous matter. Microscopic examination of the contents of the urine may show the presence of the component tissues of the tumor. Tumors, especially of the malignant kind, may be felt through the rectum; while villous tumors give rise to the almost constant presence of blood in the urine.

4. In *chronic cystitis*, without complication, the absence of the physical signs of enlarged prostate, as ascertained by examination, will establish the diagnosis.

5. In *atony* of the bladder from over-distension, the diagnosis is effected by observing the manner in which the urine flows on the introduction of a catheter. In prostatic obstruction—provided that the distension have not produced atony—the flow of urine is often forcible, and can be accelerated by the will of the patient; while, in atony, the urine simply runs out through the catheter.

6. True *paralysis* of the bladder, accompanied with a similar affection of other parts, is recognized by its concomitant conditions, and by the absence of physical signs of enlarged prostate, and, as in atony, by the passive nature of the flow of urine through the catheter.

Retention of Urine constitutes the great danger in advanced cases of enlarged prostate. It commonly comes on gradually, the patient having for some time before experienced considerable difficulty in passing his urine, and he will often find that the more he strains in his efforts to do this the less readily will it come away; whereas, when he remains quiet, it will usually flow with more freedom. The retention from prostatic enlargement is of the mixed kind, there being always more or less incontinence, or rather overflow, conjoined with it. When the bladder has become tense, and the prostatic portion of the urethra put upon the stretch, the escape of a certain quantity of urine will take place, until, by the relief of the tension of the over-distended bladder, the parts about its neck and the enlarged prostate become relaxed, so that they again fall together, and thus, the urethra resuming its tortuous condition, the outlet is occluded. In these cases error may always be guarded against by the surgeon feeling the enlarged bladder rising up above the pubes, and reaching perhaps as high as the umbilicus. This condition is an extremely dangerous one, not so much from any risk of the bladder or urethra giving way in consequence of over-distension, which very rarely happens in retention from enlarged prostate, as from the occurrence of atony of the bladder, or the probability of the early setting in of chronic inflammation of its mucous membrane, which is especially apt to take place. The bladder has usually not emptied itself completely for a considerable length of time before the retention is complete; and a quantity of ropy mucus, having collected in the fundus behind the prostate, whence it cannot be expelled, becomes putrid, and thus disposes to the supervention of that form of chronic inflammation of the vesical mucous membrane, which, occurring in a depressed state of the system, is especially apt to give rise to a brown tongue with quick pulse, and typhoid symptoms. Indeed, when death occurs from prostatic disease, it usually takes place in this way.

In some rare instances there is evidence of true incontinence of urine, the bladder being found empty and contracted, while the prostate is enlarged considerably but equally, so that the urethral orifice is patent.

Treatment.—In the treatment of enlarged prostate, little can be done by medical means; though the patient's condition may be somewhat ameliorated by remedies calculated to lessen irritation about the urinary organs, and to improve the condition of the urine. With this view, if it be very acid, alkalies with henbane should be given; if neutral or alkaline, the dilute nitric acid with henbane or opium; if mixed with ropy mucus or muco-pus, the infusion of buchu, or the balsams of copaiba or Peru, or turpentine should be administered. If hemorrhage occur, tincture of sesquichloride of iron, infusion of uva ursi, or gallic acid will be useful. Counter-irritation, the application of iodine, and other measures calculated to promote absorption of the enlarged gland, will be found of little service, and usually produce serious annoyance to the patient.

In the treatment of enlarged prostate, it is of great importance to use the catheter regularly, in order to empty the pouch that forms in the *bas fond* of the bladder

behind the prostate; and which, being below the level of the urethra, tends to collect an accumulation of viscid mucus and fetid urine which the patient cannot expel without aid, partly from their gravitating into this pouch, and partly from the muscular power of the organ being impaired. The removal of these matters is of great importance; as, independently of any retention, they may, by undergoing putrefaction, give rise to typhoid infection. The bladder should be effectually emptied at least twice *every day*. This may best be done by the introduction of a gum catheter of full size, which should be passed without the stylet. This the patient should be taught to do himself; and thus the habitual distension of the bladder, or retention in it of a quantity of urine, will be prevented, and all the accompanying constitutional disturbance averted. Sometimes, in order to reach and empty the bladder thoroughly, a prostatic catheter must be used. This instrument should be made of silver, and be of large size, equal to about No. 12. In order to properly enter the bladder, which is carried away from the surface by the elongated urethra, the prostatic should be about four inches longer than an ordinary catheter; and, as the neck of the viscus is usually pushed up high behind the pubes by the projection upwards of the lateral lobes, the curve of the instrument should be greater and longer than usual. I find the best shaped prostatic catheter to be one, the curve of which is exactly the third of the circumference of a circle five-and-a-half inches in diameter. The eyes should be large and rounded; and I have found it of use to have the lower end of the stylet provided with a piston-plate, so that, by withdrawing this, the mucus may be sucked in through the eyes of the instrument. In some cases, however, a moderately-curved gum-elastic catheter, of full size, enters the bladder most easily; in fact, no one curve nor one kind of instrument will answer in all cases. In introducing the catheter, care should be taken when the point enters the prostatic portion of the urethra, to depress the handle well between the thighs, lest the end hitch against the enlarged middle lobe (Fig. 579) or do not sweep sufficiently round the pubes. The middle lobe, even when very greatly enlarged and valvular, as was the case in Fig. 577, does not necessarily offer much obstacle to the introduction of the catheter, the point of which pushes it back. It is of great moment to ascertain that the catheter does fairly enter the body of the bladder. In enlarged prostate, the corresponding portion of the urethra is often elongated and dilated, forming a bend or pouch, containing perhaps half an ounce or one ounce of urine; this pouch the catheter may enter and empty, and the surgeon, then erroneously supposing that he has passed the instrument into the bladder, may rest content; but this is a grievous error, as the bladder is left distended beyond the pouch.

Fig. 579.

Enlarged middle lobe of prostate.

Treatment of Retention of Urine.—When retention has occurred, relief can only be afforded by the proper use of the catheter, and this should never be delayed, as typhoid symptoms in elderly people rapidly set in. Three questions present themselves in connection with the treatment of this form of retention.

1. As to the *kind of catheter* that should be used. Brodie recommends a gum-elastic instrument, long, of large size, and kept on a well-curved iron stylet, so as to preserve its curve when that is withdrawn. This must be introduced either with or without the stylet; if possible, without it. Other surgeons of great authority in these matters prefer the silver prostatic catheter; and I certainly think that *for the relief of retention* a silver instrument is safer, and more easily managed, than the gum-elastic one. It might be supposed that a less chance of mischief would result from the gum-elastic than from the metallic catheter, as being the softer and more yielding instrument; but this is erroneous, if the stylet be allowed to remain in, as it is then as rigid at the point, as hard, and as likely to penetrate soft structures as a silver one would be. If the stylet be withdrawn, it is often a very unmanageable instrument; it is impossible to know how to direct its point; and if the obstacle be difficult to surmount, it is not easy to guide the instrument over it. With the metallic catheter, on the other hand, the surgeon can feel his way as it were, and will, if he depress the handle well, as soon as the point enters the prostatic portion of the

urethra, find little difficulty in guiding it into the bladder. It is the first introduction of the instrument that especially requires care, and as much gentleness as possible; after it has once been introduced, it will almost invariably readily find its own way.

It is a question whether the patient should be placed in the erect or in the recumbent position, when the catheter is introduced for the relief of urinary retention. I certainly think that the recumbent is not only the easiest position in which to introduce the instrument, but the safest. In old and feeble subjects the sudden withdrawal of the urine, by removing compression from the abdominal veins, and allowing these vessels to refill, may induce syncope, which occurring in the erect position might prove fatal. I have heard of one case, in which the sudden death of the aged patient in such circumstances was attributed to this cause.

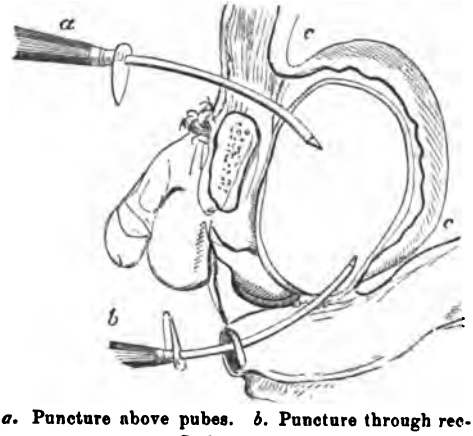
2. The next question in connection with the relief of retention in these cases is, whether the catheter should be *left in the bladder*, or be *withdrawn* after the viscus is emptied. As a general rule, it is certainly far better not to leave the catheter in; its presence in the diseased bladder setting up a low form of inflammation, or giving rise to sloughing of the mucous membrane. The instrument should be introduced twice in the twenty-four hours; and care should be taken, if possible, to empty the pouch behind the prostate by depressing its point. When the instrument is used habitually in this way, the gum-catheter may be employed. Should the mucus be very viscid and offensive, the bladder may be washed out with tepid water through a double current catheter. After the bladder has been emptied for the first time, it will be found to refill in the course of a very few hours, usually in six or eight, the secretion of the kidneys appearing to be set free on the removal of the pressure.

Should any great difficulty be experienced in introducing the catheter, it may be thought desirable to leave it in the bladder for two or three days; and then a gum-elastic one is always to be preferred, as in these circumstances it presents a great advantage over the silver catheter, becoming soft, accommodating itself to the shape of the parts after the stylet has been taken out, and not being so liable to irritate the mucous membrane with its point, which, dipping down into the pouch behind the prostate, acts as a syphon, emptying this part of the bladder far better than a silver catheter could do.

3. The third question in connection with the relief of retention from enlarged prostate, is as to the course that should be pursued *if no instrument can be introduced into the bladder* in the ordinary way. In these cases, which, however, very rarely occur, three lines of practice may be adopted; *puncture of the bladder above the pubes*, *puncture through the rectum*, or *forcible catheterism*.

Puncture above the pubes can very seldom be required. Since the University College Hospital was opened, only three cases have presented themselves in which it was thought proper to adopt such a procedure for retention from enlarged prostate; and in one of these cases, which was under my care, the enlargement of the prostate was complicated with impermeable stricture, which was, indeed, the main cause of the retention. The operation consists either in pushing the trocar at once through the abdominal wall; or else, as in tapping for ascites, making a small incision about half an inch in length through the integuments, exactly in the mesial line, immediately above the pubes, and then passing a curved trocar, with its concavity downwards and backwards, into the bladder behind that bone, and consequently underneath the reflection of the peritoneum (Fig. 580, *a*). After the bladder has been emptied, the canula or an elastic gum tube must be left in for the escape of urine, whilst the continuity of the natural passage is being restored. When the bladder is greatly distended, in consequence of retention from enlargement of the prostate or any other cause, the peritoneal reflection is carried up with it, and a considerable portion of the anterior wall of the organ

Fig. 580.



a. Puncture above pubes. *b*. Puncture through rectum. *c. c*. Reflexions of peritoneum.

uncovered by peritoneum is left above the pubes. In a case of unrelieved retention from stricture, in which the patient died suddenly during the administration of chloroform, and which I had an opportunity of dissecting, I found that the fundus of the bladder reached to five inches above the symphysis pubis, and was only two inches below the umbilicus; that the line of reflection of the peritoneum was $3\frac{1}{8}$ inches above the bone; and that the space uncovered by serous membrane was $2\frac{1}{4}$ inches wide. The bladder contained nearly forty ounces of urine, the retention having lasted during forty-eight hours.

Brander of Jersey and others have modified this operation by puncturing through the symphysis pubis, by means of a trocar and canula. There is not, however, sufficient evidence to enable us to decide as to the merits of this procedure.

Puncture through the rectum is not generally a safe procedure in retention from enlarged prostate, in consequence of this structure encroaching on that part of the inferior fundus of the bladder which is uncovered by peritoneum. When, however, the retention arises from enlargement of the urethral portion rather than of the lateral lobes, this operation may be safely done; and, indeed, I have known it put in practice with advantage in such cases (Fig. 580, *b*).

A safer procedure than this, and one that is recommended by Brodie, Liston, and most surgeons of authority in these matters, is *forcible catheterism*, or *tunnelling the prostate*. As the retention is generally owing to an enlargement of the urethral portion of the prostate, relief may be afforded by pushing the point of a silver catheter through this obstacle into the bladder. A false passage is thus formed, in which the instrument should be left for about forty-eight hours, when it will generally enter it with sufficient readiness on being introduced again.

After the retention has been relieved, the bladder will often remain in an atonic state for a time, the urine flowing out, but with no power of expulsion, for some weeks. In these circumstances the catheter should be used twice in the twenty-four hours; good diet, with wine, quinine, and extract of nux vomica may be given, and blisters applied to the sacrum; afterwards the patient should be taught to pass the catheter for himself once or twice daily.

The radical cure of the impediment to the flow of the urine has been proposed to be effected by removing the enlarged middle lobe of the prostate by ligature, by excision with a lithotrite, or by lateral or median incision of the perineum. Such operations, however, from their difficulty and danger, should not be lightly undertaken; perhaps the least dangerous mode of removal would be by median urethrotomy.

OTHER DISEASES OF THE PROSTATE.

Atrophy of the Prostate sometimes occurs. It may be the result of exhausting disease, especially phthisis, of old age, of mechanical pressure, from tumors or calculi, or of local disease of the gland itself. The atrophy may also be congenital.

Malignant Disease of the Prostate is of rare occurrence; and, when it occurs, is most commonly of the encephaloid form. It has been observed only in childhood and in advancing age. Its presence may commonly be ascertained by exploration through the rectum and urethra. The passage, also, of bloody urine, or of clear urine followed by a discharge of blood, mixed, perhaps, with the *débris* of a cancerous growth, will likewise tend to establish the nature of the affection, which is necessarily fatal, and admits of palliative treatment only.

Tubercle of the Prostate is occasionally, but rarely, met with; and is to be regarded as a manifestation of a constitutional disease.

Cysts or Cavities are sometimes found in the prostate; they may be dilatations of gland-follicles, abscesses, or cavities containing concretions or calculi.

Prostatic Calculi have been already described in the chapter on urinary calculus (p. 1082).

Prostatorrhœa has been described by Gross as a discharge of clear glairy mucus from the prostate, in consequence of irritation of that organ. The disease is characterized by the discharge of a few drops of ropy, viscid mucus from the urethra after micturition or defecation. It is chiefly of importance from its liability to be confounded with spermatorrhœa, and from the depressing effect consequently produced upon the patient's mind.

The *diagnosis* of prostatorrhœa from *spermatorrhœa* may be effected by microscopical examination of the characters of the discharge.

The *treatment* consists in attention to the state of the general health; the administration of tonics, more especially of iron and nux vomica; the removal of any local source of irritation in the urethra, rectum, or anus, as stricture, piles, or fissure; and the local application to the prostatic portion of the urethra of the nitrate of silver. The application of a blister to the perineum is beneficial in some cases.

CHAPTER LXX.

DISEASES OF THE URETHRA.

URETHRITIS.

Simple inflammation of the urethra is especially apt to occur in strumous, rheumatic, or gouty individuals, from slight sources of irritation, either direct or sympathetic, that would not excite it in more healthy constitutions. In strumous children, it may arise from worms in the intestines, or from gastric irritation; and in gouty or rheumatic subjects, it appears often to occur in connection with an acid or loaded state of the urine. In other cases, the irritation of a stricture, the passage of instruments, or ordinary sexual intercourse, may occasion the disease, without there being anything of a specific or venereal character about it. Contact with women who are out of health, pregnant, or suffering from leucorrhœa, may and often does give rise to local irritation of this kind. Urethritis, especially when arising from sexual intercourse, is frequently mistaken for gonorrhœa; but from this it may be distinguished by the less intense degree of inflammation, and by the absence of the secondary consequences that frequently follow true gonorrhœa; yet, in many instances, the diagnosis is extremely difficult, especially from the subacute forms of gonorrhœa that are so common in London.

Symptoms.—Urethritis is characterized by heat, pricking, and tension about the urethra for a day or two, followed by a muco-purulent discharge, often rather profuse, and accompanied by some ardor urinæ. The symptoms altogether are not severe, and the disease usually subsides at the end of a week or ten days; but sometimes it becomes chronic, especially if conjoined with stricture, and then constitutes an extremely troublesome affection, more particularly in gouty individuals.

Treatment.—The treatment of urethritis is mildly antiphlogistic. The bowels should be kept open, and salines freely administered; in many cases small doses of colchicum, in combination with alkalies, will be found of especial service in cutting the disease short. The use of emollient or slightly astringent injections, such as opiate lotions, or a very weak solution of acetate of lead, with belladonna, will be found serviceable as the disease is on the decline, but not till then; and when the affection has reached a chronic stage, small doses of copaiba may be advantageously administered. The diet in all cases should be of the blandest character, stimulants of all kinds being interdicted.

If the disease be conjoined with slight stricture, it may not unfrequently give rise to temporary retention of urine. This may, however, most commonly be readily relieved by antiphlogistic treatment, cupping or leeches to the perineum, the warm hip-bath, and salines, with, perhaps, opiate suppositories, and plenty of demulcent drinks. The catheter should not be used in these cases, if it be possible to give relief without it.

Urethral Abscess occasionally forms as the result of urethritis, a soft fluctuating point being perceived in the neighborhood of the canal. As soon as this is detected it should be opened, when the aperture that results will readily close. If left, it will probably not burst externally, but into the urethra, the tissues in this direction being less resistent; and then, if it should be opened externally as well, a troublesome urinary fistula will result.

Perineal Abscess may form as the result of stricture or of urethritis, in whatever way excited; the patient complaining of a sensation of weight, with pain and

throbbing, deep in the perineum. On examination, a hard tense swelling will be found, situated a little anteriorly to the anus, and extending along the side of the urethra. It presents no sign of fluctuation until it comes forwards into the scrotum.

The *treatment* consists in the application of leeches, followed by fomentations, and an early incision through the perineum into the swelling. In some cases, the abscess is situated altogether externally to the urethra, and then the aperture closes readily enough, like that of any other ordinary abscess. In other cases, it communicates with the canal, and then fistulous openings are left, through which a certain quantity of urine escapes. These apertures gradually tend to close if they be not complicated with stricture or other urethral disease; should they be so, they will require special treatment, of a kind that will be described at p. 1134.

GONORRHŒA.

Gonorrhœa is a specific disease, accompanied by inflammation and an abundant muco-purulent discharge; affecting the urethra most commonly, but also the other mucous membranes of the genital organs, as of the prepuce and the glans in the male, and of the vulva and vagina in the female.

[Any mucous membrane may be the seat of gonorrhœa; thus Chelius and Vidal (de Cassis) have seen it affecting the rectum and anus, B. Bell the nose, and Baumés the mouth. The ordinary gonorrhœal ophthalmia might more correctly be called ophthalmic gonorrhœa.—A.]

The urethra is the usual seat of gonorrhœa in the male; and the disease may be looked on as a specific urethritis. It is usually fixed with greatest intensity in the fossa navicularis; but it may extend itself over a much greater surface, affecting the entire length of the canal, and even the whole mucous lining of the bladder. In the female it commonly spreads over the extensive mucous surface of the internal organs of generation, and sometimes even invades the uterus.

Cause.—Gonorrhœa is a truly specific and a highly contagious affection, arising in all cases from the application of a peculiar animal poison, generated by impure and indiscriminate sexual intercourse, to the parts which it attacks, and must not be confounded with the various non-specific inflammatory diseases that may affect the parts commonly the seat of gonorrhœa, and which are all characterized by muco-purulent discharges.

The poison of gonorrhœa differs entirely from those of the venereal diseases described in Chapter XXXVI., as has been fully proved by the unerring test of inoculation; these diseases not being capable of reproducing one another under any circumstances.

Character.—Gonorrhœa is usually looked upon as a purely local affection of the genital organs. Some surgeons, however, amongst whom may be especially mentioned Travers, seem to consider it as occasionally assuming a constitutional character; in this opinion I entirely agree. Although gonorrhœa in the early stages is doubtless a strictly local affection, yet it is occasionally followed by a particular train of very characteristic phenomena, that can scarcely be looked upon in any other light than as the result of constitutional infection; the more so, as some individuals never have gonorrhœa without the disease being followed by these sequences, whilst others are altogether exempt from them. The parts that are secondarily affected are chiefly the fibrous tissues, the mucous and the cutaneous surfaces. The affections of the *fibrous tissues* give rise to rheumatism, and to peculiar forms of inflammation of the testicle and of the sclerotic. The affection of the *mucous membrane* displays itself in specific inflammations of the throat, and of the eyes; and the *skin* becomes the seat of certain eruptions. The occurrence of these various affections, assuming as they do a specific type so distinctly marked that they can at once be characterized as gonorrhœal, certainly tends to show that the disease impresses the constitution in some peculiar manner, somewhat analogous to syphilis; though in a far minor degree, and with much less certainty, than the latter disease.

Symptoms.—The symptoms of gonorrhœa in the male may be divided into three stages: 1. The incubative stage, or the period of irritation; 2. The acute stage; and, 3. The chronic stage.

1. *Incubative stage.*—The first stage, that of irritation, usually comes on from three to five days after connection, when the patient begins to experience some

degree of heat, itching, and a general irritation about the penis. The lips of the urethra are somewhat red and swollen; its orifice gapes; and, on squeezing it, some muco-pus exudes. This stage usually commences about the time mentioned, but sometimes sets in immediately after connection; in other instances it does not occur for eight or ten days; after lasting for twenty-four or forty-eight hours it terminates in the second stage, which is one of active inflammation.

2. *Acute or inflammatory stage.*—The discharge now becomes abundant, thick, and of a greenish-yellow color; there is great pain in passing urine, with considerable heat and smarting, and the urine flows in a diminished stream, but is passed with increased frequency. The urethra is swollen, firm, and cord-like to the touch; the whole penis, indeed, looks generally red and turgescent. As the disease advances, and the bulbous portion of the urethra becomes affected, tension in the perineum will be complained of. If the prostatic portion be the seat of disease, there will be heat and weight about the anus. During the whole of this period there is generally a good deal of constitutional disturbance, restlessness, and fever.

One of the most troublesome symptoms in this stage of the complaint is the occurrence of *chordee*, which consists in painful erections at night, with a twist in the body of the penis, which is usually curved down towards the scrotum.

3. *Chronic stage.*—These symptoms usually continue for about a fortnight, when the third stage, that of subacute or chronic inflammation, sets in. During this period of the affection the inflammatory symptoms gradually subside, but a thin muco-purulent discharge keeps up, with some degree of heat and irritation about the urethra, and occasional smarting in passing urine. Under proper treatment, this usually subsides in the course of another fortnight or three weeks; but, if neglected, or in certain constitutions, it may last for many months, or even years, then degenerating into a *gleet*. In proportion to the continuance of the affection the inflammatory symptoms subside, though the specific and contagious character does not disappear, and the infection may continue so long as the discharge keeps up. Hunter mentions the case of a girl who had been two years in the Magdalen Hospital, and who infected a person with whom she had connection immediately after she left that institution. The persistence of the contagion of gleet is, it is true, more marked in women than in men. So long, however, as any discharge continues from the male urethra, the patient must be looked upon as infectious.

The severity and the continuance of gonorrhœa are often opposed to one another. Thus the disease is most severe in young and plethoric persons, and in first attacks; but it is most difficult of cure in strumous and phlegmatic constitutions, more especially if there be a gouty or rheumatic tendency coexisting, and is very troublesome to remove after repeated attacks. I have observed repeatedly that it is very apt to degenerate into a gleet in people who are subject to chronic diseases of the skin.

The length of time that the infection of gleet will continue in both sexes, but especially in the female, makes it somewhat difficult to say whether the poison of gonorrhœa can be generated *de novo*, as it is not improbable that many individuals communicate the disease, believing themselves to be perfectly cured, though still suffering from slight gleet.

Treatment.—The treatment of gonorrhœa must be conducted with reference to the stage to which the disease has attained, but especially with regard to the amount of inflammatory action accompanying it. It is of two kinds, *rational* and *specific* or *empirical*. Both plans are useful, and, indeed, usually necessary for a proper cure, but they cannot be adopted indiscriminately. Thus, if specific means be employed during the acute inflammatory stage of the complaint, much mischief may ensue; whilst, if antiphlogistic treatment be persevered in for too long a time, the disease may be kept up indefinitely.

It has been proposed to adopt what has been termed the *abortive* or *revulsive* treatment, during the earliest stages of gonorrhœa; indeed, during the *incubative* period. This method consists either in the injection of a very strong solution of the nitrate of silver into the urethra, or in the application to the inflamed mucous membrane of a strong ointment of that salt by means of a bougie smeared with it; other surgeons, again, have recommended the administration of very large doses of copaiba at this period. These various plans, have, however, deservedly fallen into disrepute. I have on several occasions seen most intense inflammation produced by this mode of treatment, and never, in any case, any good result. Independently of this, it is

impossible to know whether the case, in the earliest stage, will prove to be one of simple urethritis or a specific gonorrhœa.

In the *acute inflammatory stage*, attended by heat, swelling of the organ, great ardor urinæ, and abundant muco-purulent discharge, the treatment must be entirely antiphlogistic, the activity of the measures being proportioned to the intensity of the inflammation. If this be very severe, leeches may be applied to the perineum, or to any very tender point along the urethra. If it be not so intense, warm hip-baths, poppy fomentations, or the envelopment of the penis in warm-water dressing, will be of essential service. At the same time the urine must be diluted, and its acidity lessened, by the patient drinking large quantities of alkaline diluents—barley-water or linseed tea containing a little nitre or carbonate of potass in solution, or soda-water; and the skin and bowels may be kept in action by the administration, every fourth or sixth hour, of a powder composed of a drachm of sulphate of magnesia, 5 grains of nitre, and $\frac{1}{12}$th of a grain of tartar emetic, dissolved in a wine-glass of water. All stimulants must be avoided, the diet being restricted to light slops, and perfect rest enjoined. By such means as these, the activity of the inflammation will be gradually lessened, the discharge becoming thinner, the smarting in micturition less severe, and the erections less painful. The patient should also be desired to pass his urine frequently, so that it may not be too concentrated.

When the *third stage* of the disease has been reached, specific treatment may be employed with great advantage; while, if recourse were had to it at an earlier period, it would certainly increase the inflammatory action and give the patient much distress. Even in this stage the specific remedies, such as copaiba and cubebs, must be cautiously given; the surgeon feeling his way with them, and being prepared to discontinue them and to return to strictly antiphlogistic measures, if he find that they increase the irritation. Should the disease, however, from the commencement, have assumed a subacute character, the specific treatment may with safety be adopted at a much earlier period.

Copaiba and cubebs are the remedies that are almost universally used in this stage of gonorrhœa. Of these copaiba is the least irritating, and consequently most generally to be preferred. It may be administered in a variety of ways; in capsule, pill, draught, or extract. The capsule is generally to be preferred, on account of the nauseous taste being thus more readily disguised; but in many cases it acts with more certainty, and with better effect, if given in either of the other forms. When the capsules are given, the patient may take from six to eight or ten in the day, and should at the same time have an alkaline mixture, which increases materially the effect of the drug. A very excellent mode of administering copaiba is to rub it down into a mass with burnt magnesia, and to let the patient take about a drachm of this paste three times a day, in a bolus wrapped in wafer-paper; or, if the taste be not much objected to, he may take it most advantageously in mucilage, with liquor potassæ and tincture of henbane.

In some relaxed constitutions, and more particularly after frequent claps, cubebs will be found to cure the patient more readily than copaiba, or rather most successfully if given in combination with it. An excellent plan is to put about half an ounce of powdered cubebs into a mortar, and to rub it up with as much copaiba as will form a stiff paste, of which the patient should take a drachm as a bolus thrice daily. The effects of this electuary are often most striking; but it can only be used in the constitutions indicated, and after the more active inflammatory symptoms have subsided.

It is during the third stage of gonorrhœa that *injections* may advantageously be used. Much and very unfounded prejudice exists against their use in the minds of many; but surely it is as safe to apply proper local applications to an inflamed urethra as it is to an inflamed conjunctiva; and the bad consequences, such as stricture and inflamed testicle, which have sometimes been referred to their use, have either been due rather to the long continuance and to the severity of the disease itself than to the remedies employed, or to their application at too early a stage or of too great a strength. It is in long-standing cases of gonorrhœa, in which the discharge continues for months or years, that stricture results, not in cases of ordinary duration; and in these it is the result of the chronic inflammatory thickening of the mucous membrane, and has no more to do with the injections than with the copaiba or salines the patient may have taken. As the ardor urinæ subsides, emollient and slightly astringent injections may be used. The best is perhaps the

induce irritation, a few grains of the watery extract of opium may advantageously be added. As the disease subsides, a stronger astringent is required, and then one or two grains of the acetate of zinc may be added to each ounce of the injection; or a very weak solution of sulphate or chloride of zinc may be employed, gr. ij of the first, and gr. j of the second, to each ounce of water; or an injection of gr. $\frac{1}{4}$ of the nitrate of silver to the ounce may be used. During the whole of this stage, the diet and habits of life must be carefully regulated, and all stimulants interdicted. The injections should be discontinued as soon as the discharge has ceased; unless this be done, they may reinduce it.

The mode of injection is of importance. A glass syringe should always be used, with a smooth rounded nozzle. The patient sitting on the edge of the chair and holding up the penis, should carefully insert the end of the syringe between the lips of the urethra, and then slowly throw in the injection as far as it will go. Although the inflammation is usually confined to the anterior portion of the urethra, yet it may extend to the bulb, and the injection should be applied to the whole length of the inflamed mucous membrane. If any enter the bladder it cannot signify, as it will immediately be decomposed by the salts and mucus of the urine.

In *gleet*, much difficulty will often be experienced in curing the patient of his discharge. Here much depends not only on the administration of proper remedies, but in care being taken attentively to regulate his habits of life. It will constantly be found that, after the disease has apparently been cured, excesses at table, and more especially the drinking of beer, or of effervescing or acid wines, will bring back the discharge. It will also return after connection, though it have previously ceased entirely. This is especially the case in strumous, gouty, or rheumatic constitutions, in which all urethral inflammations are with difficulty removed. In these cases, then, abstinence from all stimulants, dietetic as well as alcoholic, and improvement of the tone of the system by change of air, sea-bathing, &c., will often be of essential service. At the same time, the electuary of cubebs and copaiba, or one composed of cubebs and the sesquioxide of iron, may be administered with advantage. In other cases, especially in relaxed constitutions, tincture of perchloride of iron, alone or conjoined with a few drops of spirits of turpentine or tincture of cantharides, will produce much advantage.

In chronic gleet, local applications will be found to be necessary for the cure of the disease. Amongst these I have found none more useful than one composed of ten grains of chloride of zinc and one scruple of gallic acid to eight ounces of water. In some cases injections of nitrate of silver, of the strength of half a grain, or of bichloride of mercury, in the proportion of a quarter of a grain to the ounce, will be serviceable. And, indeed, in most instances it is beneficial to vary the injections; the mucous membrane appearing to become accustomed to the same stimulant after a time, and thus not being impressed by it in a proper manner.

After the gleet has continued for some months, more benefit will often be derived from the introduction of a full-sized metallic bougie every second or third day than from any other local means, even where no stricture exists. The instrument should be left in for about ten minutes, and should be of the largest size that the urethra will admit.

[In this country the treatment of gonorrhœa by means of injections is deservedly popular. In the earliest stage of the disease an injection of nitrate of silver (gr. $\frac{1}{4}$–f$\bar{3}$j) is very effective. With this I have occasionally succeeded in curing a gonorrhœa in the course of a few days. In the after stages a combination of the acetate of lead, sulphate of zinc, and acetate or sulphate of morphia has proved useful, while in the chronic stage sulphate of copper (gr. ij–f$\bar{3}$j) is an excellent injection. A saturated solution of tannic acid may be employed when the disease has run into a gleet. Scalding may be relieved by drinking flaxseed-tea containing bicarbonate of soda and sweet spirit of nitre, and this is the only medicine that need be taken by the mouth in the majority of cases. Copaiba and cubebs may be used with advantage in some of the more obstinate cases. I have give copaiba as an injection as recommended by Dallas, but without success; it appears to be necessary to medicate the urine with it to obtain its full effect. While perfect rest is desirable in the treatment of gonorrhœa it is not indispensable, and occasionally in private practice, where concealment is wished, cannot be obtained. In such cases the patient should constantly support the scrotum in a suspensory bandage.—A.]

Complications of Gonorrhœa.—Gonorrhœa, when acute or virulent, seldom runs its course without local complications of some kind, the result of the propagation of the inflammation to neighboring parts, often of considerable severity, and occasionally even hazardous to life—such as chordee, phimosis, sympathetic bubo, perineal abscess, irritability of the bladder, retention of urine, hemorrhage from the urethra, &c. Many of these complications present no special features, but require to be treated on general principles, without reference to their specific cause. Others demand more special management, and these we may briefly consider here.

Chordee, or painful erection of the penis, with twist of the organ, coming on at night, is often a most distressing and troublesome symptom. It is usually best relieved by the application of cold to the part, but more especially by the administration at bedtime of a pill composed of gr. j of opium with gr. v of camphor, the camphor acting as a direct sedative to the generative organs. Ricord recommends a suppository of camphor and opium, gr. x of camphor, and gr. j of the watery extract of opium, to be introduced into the rectum an hour before bedtime, as the best means of removing the tendency to chordee.

[In addition to the suppository above recommended, the application of belladonna or even of an ice-bag to the perineum will be found of use in relieving chordee.—A.]

Irritability of the bladder with spasm of the neck, strangury, and dysuria, may be of two kinds; either *inflammatory*, coming on in the earlier stages of the disease with pain in the perineum, and all the symptoms of active inflammation about the part strongly marked; or *atonic*, supervening at a more advanced period, without any special signs of inflammation. In the first case, leeches to the perineum, hot poppy fomentations, the warm bidet, with full doses of Dover's powder, or of henbane and carbonate of potass or nitre, will probably afford much relief. When the disease is *atonic*, the administration of tincture of perchloride of iron, conjoined with local soothing remedies, as the poppy fomentations or bidet, and an opiate suppository, will be beneficial.

Retention of urine from gonorrhœa.—The obstruction is usually dependent on congestion and inflammation of the mucous membrane of the urethra. Leeches to the perineum, the warm hip-bath, and opiate suppositories will probably afford relief. It is always desirable to avoid using the catheter, as it is apt to lacerate the swollen and softened mucous membrane, and thus to occasion troublesome bleeding; and will always produce much pain, and increased irritation of the canal. Should, however, the retention have continued twenty-four hours, or longer, it will probably not give way to the means above indicated, and then it will be necessary to use the instrument, when a full-sized silver one should be very carefully introduced; a large instrument entering the bladder as easily as a smaller one, and with less risk of injury to the tender walls of the canal.

When the catheter has been introduced, it is often somewhat difficult to determine whether it should be left in or taken out. If it be left in, inflammatory action is increased. If it be taken out, the surgeon may not be able easily to introduce it again. The solution to this question is to be found in the facility with which the instrument is passed. If it have been introduced without much difficulty, it is better to withdraw it after the bladder has been emptied, and to continue the antiphlogistic treatment, when a second introduction may not be required. If, on the other hand, the catheter have been passed with great difficulty, and be firmly grasped either by spasm or stricture, it should be left in; but very active treatment must be employed to prevent it from exciting too much inflammation.

It must, however, be remembered that the retention may be due to more serious conditions; to prostatitis, to abscess in the prostate or the perineum, or to inflammatory exudation in the tissues about the neck of the bladder. In these circumstances, more active antiphlogistic measures will be required, with the use of the catheter twice in the twenty-four hours, and probably free incision into the perineum, if there be pus or urine extravasated into that region.

In many cases of gonorrhœal retention, there is an old stricture as well as the clap. Here the employment of energetic antiphlogistic measures and the use of the catheter are indicated; but, as the stricture is the chief cause of obstruction, the treatment must be directed to it.

Hemorrhage from the urethra may occur either as the result of chordee, and consequent rupture of some bloodvessels of the corpus spongiosum, as the consequence of attempts at passing the catheter, or as a kind of exudation from the mucous mem-

brane. Most commonly it may be arrested by the application of ice, and the employment of moderate local antiphlogistic treatment. Should it be abundant, the introduction of a lare gum-elastic catheter, and pressure by means of a bandage to the penis or perineum, will arrest it.

Sequences of Gonorrhœa.—The sequences, or more remote complications of gonorrhœa, are partly local and partly constitutional. Amongst the local we find more particularly *warts* about the prepuce and glans or within the urethral orifice, which require to be treated by excision or caustics; and *stricture*, the management of which is fully described elsewhere. In some cases, also, in consequence of extravasation of blood, or the effusion of plastic matter into the corpus spongiosum or the corpora cavernosa, limited and localized *induration and thickening of the penis* may result, attended by chordee, painful erections, and a permanent twist in the organ. In such conditions as these, absorption of the effused mass may be attempted by the administration of small doses of bichloride of mercury, with the inunction of iodide of lead ointment.

After the cure of a clap that has been of long continuance, the generative organs are often left in a *weak and irritable state;* the penis, scrotum, and spermatic cords being lax and elongated, with an apparent want of power, and often painful and dragging sensations about the cords and groins.

Besides the strictly local complications of gonorrhœa, a certain set of sequences to which some constitutions are especially liable, occasionally occurs as the result of this disease; viz., inflammation of the testes and of the eyes, rheumatism, cutaneous eruptions, and sore throat. Some of these, as the affections of the eyes and testes, may be either local or constitutional; the others are clearly constitutional.

Gonorrhœal inflammation of the testis is certainly the most common of these sequences. It most invariably affects only one testis, and commences in the epididymis, whence it extends to the body of the organ. It usually occurs in individuals who have a lax and long scrotum, with very pendulous testes. It seldom sets in before the third week after the occurrence of gonorrhœa, but may occur at any period during the continuance of the discharge, though it is more frequent between the fifth and sixth weeks than at any other time. In cases of gleet, also, it not uncommonly occurs at a later period. In many instances it is referred to some slight injury—a blow, or squeeze, received during the continuance of the gonorrhœa; but in other cases it would appear to arise from extension of the inflammation along the ejaculatory duct; and in others from a kind of metastasis of the morbid action from the urethra to the testis. That the disease commences in the epididymis, may be advanced in support of the first opinion; whilst the fact that the discharge usually ceases when the inflammation of the testicle comes on, and returns as it subsides, may be adduced in support of the doctrine of its metastatic origin. [The doctrine of metastasis is, I believe, rejected by most authorities of the present day. Certainly in most, if not in all, of the cases of epididymitis which have come under my care, the urethral discharge has continued throughout.—A.] As the symptoms and treatment of gonorrhœal inflammation of the testicle present nothing peculiar, I shall reserve their consideration until we speak of diseases of this organ.

Gonorrhœal inflammation of the eyes is fortunately not of very common occurrence. It may affect either the conjunctiva or the sclerotica.

Gonorrhœal conjunctivitis is one of the most destructive forms of ophthalmia, giving rise not unfrequently, in the course of forty-eight hours, to the most intense chemosis, with opacity and softening of the cornea, followed by staphyloma and a discharge of the humors. In the majority of instances only one eye is affected; but, in some, both are involved to an equal extent. The disease commences with the ordinary symptoms of conjunctival inflammation; itching and swelling of the eyelids, velvety redness of the conjunctiva, muco-purulent discharge, with much lachrymation. The chemosis sets in early, and is very severe; and, unless treatment afford speedy relief, the consequences are most disastrous to vision. Lawrence states that, of 14 cases that fell under his observation, 9 had only one eye affected and 5 both. Of the 9 in whom one eye only was diseased, the organ was lost in 6 cases; of the 5 in whom both eyes were affected, both organs were destroyed in one case; in 2 one eye only was lost; one patient recovered imperfectly; and in only one did complete recovery ensue.

It has been a question with surgeons, whether gonorrhœal ophthalmia is the result of the direct application of the specific pus to the conjunctiva, or occurs as a con-

stitutional disorder. There can be little doubt that the application of the pus to the surface of the conjunctiva might occasion the disease, but at the same time it is perfectly certain that in many instances there is no evidence of contact; the inflammation occurring in both eyes without the patient having apparently communicated it; and, though it is necessarily difficult to adduce positive proof on this point, it is but reasonable to presume that such cases may be constitutional.

The *treatment* of this dangerous affection must be of an active character; blood should be taken freely from the temples by cupping, or, if the patient be sufficiently robust, from the arm, as strongly recommended by Lawrence, who placed great reliance on it; he must of course be kept in a dark room, and on strict antiphlogistic regimen. The disease must, however, be met, and the eye can alone be saved, by active local treatment. The most active topical agent that we possess is the nitrate of silver. The use of this astringent, originally introduced by Littell, has been much insisted on by Guthrie, Walker, and others, and is generally adopted at the present day, being certainly the most useful agent that we possess. Surgeons differ somewhat in opinion as to the strength of the application; some, the Germans especially, advise that the solid stick should be used; whilst others employ it in solution, of the strength of a drachm to the ounce of distilled water. Wharton Jones employs a weaker solution, one of four or five grains to the ounce, and I have seen cases very successfully treated by this plan; so much so, indeed, that I am disposed to prefer it to the stronger solution. A few drops must be introduced about twice in the twenty-four hours, into the inner canthus of the eye; the lids in the meantime being kept covered by compresses dipped in weak alum lotion, and the purulent discharge, as it accumulates, carefully washed away by tepid alum injections. In doing this, great care must be taken that none of the discharge come into contact with the eyes of the surgeon or nurses, as it is highly contagious, and will almost to a certainty produce the disease; instances are recorded in which, in this way, the attendant's vision has been destroyed. If the chemosis be considerable, it must be incised; and, as the inflammation subsides, belladonna lotions may be employed with advantage, and the use of the nitrate of silver gradually discontinued.

[I cannot accede to the propriety of the antiphlogistic course recommended by the author. The local treatment should be energetic: scarification of the conjunctiva if the chemosis be great, and the application of a strong solution of nitrate of silver or of chloride of zinc will be found very useful. The eyes should be kept constantly free from discharge by means of syringing, which effects the purpose better than mere bathing. The patient should be kept quiet, and should be allowed nutritious though unirritating food. Even if perforation of the cornea and prolapse of the iris take place, useful vision may occasionally be preserved.—A.]

Gonorrhœal sclerotitis is by no means of such frequent occurrence as the conjunctival inflammation; when it happens, it will commonly be found to be associated with gonorrhœal rheumatism, and not unfrequently with inflammation of the testicle, occurring apparently in individuals in whom there is a tendency to affection of the fibrous tissues. This disease is evidently of constitutional origin, as it cannot possibly arise from local contagion; it is attended by the ordinary signs of sclerotic inflammation, and is usually accompanied by some degree of iritis.

In the *treatment* there is nothing very peculiar. Cupping or leeches to the temples, with belladonna fomentations, are the principal local means; and calomel and opium, continued until the gums are affected, constitute the chief internal remedies; these means must be persevered in until the anterior chamber clears, and any effused lymph is absorbed. As the disease declines, and especially if the patient be somewhat debilitated, soda, rhubarb, and bark in powder may be given internally, and blisters kept open on the temples.

[I have never had occasion to deplete in these cases; instillation of a solution of atropia and the internal exhibition of oil of turpentine and iodide of potassium have always in my hands been sufficient to induce recovery.—A.]

Inflammation of the nose, attended by profuse suppuration, is a complication that I have more than once had occasion to observe in gonorrhœa. The swelling of the organ is considerable, the tenderness great, and the discharge abundant; a condition, indeed, of the Schneiderian membrane that seems analogous to the inflammation of the conjunctiva just described.

The *treatment* that I have found to succeed best, consists in fomentations followed by astringent lotions or injections.

Gonorrhœal rheumatism principally occurs in young, florid, and otherwise healthy men. It is of two kinds; in one, the most common, and, indeed, the typical variety, the fibrous and muscular structures are affected; in the other the joints are implicated. The fibrous or muscular form of rheumatism is not unfrequently associated with inflammation of the testicle or of the sclerotic. It commonly affects the fleshy parts of the body, as the hips, the shoulders, and the thighs, and not unfrequently occurs in the soles of the feet. It is always painful at night, but is not commonly attended by any very severe constitutional disturbance. The synovial form presents the ordinary characters of rheumatism of the joints, the knees and ankles being those chiefly involved.

[Gonorrhœal rheumatism presents many analogies to *pyæmia*, of which disease many writers consider it a variety (see p. 461).—A.]

In the *treatment* of these affections, calomel and opium, or Dover's powder with colchicum, must constitute the most important elements until the acute stage is passed, when iodide of potassium may be advantageously given.

Cutaneous eruptions, chiefly consisting of roseola, with slight pityriasis, and perhaps a few patches of psoriasis with very flimsy scales, occasionally occur in rather severe cases of gonorrhœa, usually appearing from six weeks to three months after the commencement of the attack. They are chiefly diffused about the chest and belly, and present no sign of coppery redness. At the time of their occurrence, the fauces commonly become similarly involved, presenting, as was first pointed out by Travers, a diffused superficial redness on the velum palati and pillars, with perhaps superficial ulceration on these, the tonsils, or the uvula. The occurrence of these affections is usually preceded by slight febrile action, which, however, subsides on their full evolution. The roseolar eruptions, occurring during gonorrhœa, have occasionally been attributed to some peculiar influence exercised by the copaiba, but I think not on sufficient evidence. I am not aware that copaiba, when administered for other diseases than gonorrhœa, ever produces such eruptions; and they will occur, as I have seen in several instances, when no copaiba is being given.

[That copaiba does produce eruptions when given for other affections than gonorrhœa is proved by a case reported by the late Dr. Thos. T. Hewson of this city. (*N. A. Med. and Surg. Journal*, vol. v. p. 78). Cases of eruption following gonorrhœa, where no copaiba has been given, must be rare, and I should rather attribute them to coincidence than to any effect of the urethral condition. (See also a paper by F. Simms in *Brit. Med. Journ.* for March 13, 1869, p. 235.)—A.]

The *treatment* of these affections should consist in the administration of salines, followed by iodide of potassium in small doses. Mercurials are never required.

Gonorrhœa in the Female differs from the same affection in the male in not being so severe, though it is usually more extensive, and of longer duration. The severity is less, on account of the shortness of the female urethra, preventing the occurrence of the retention of urine as in the male, and also from the absence of such parts as the prostate, testes, &c., the implication of which constitutes the principal source of difficulty in men. Gonorrhœa in the female may affect the part to very different degrees; thus, the vulva alone may be implicated, or, as most commonly happens, the inflammation may spread to the whole of the mucous membrane of the vagina. The urethra is less commonly the seat of disease, though occasionally implicated with other parts; and, lastly, the interior of the uterus may become affected by this specific inflammation. In some cases it will even spread along the Fallopian tubes to the ovaries: and I have known one or two cases in which rather acute attacks of peritonitis, probably induced in this way, have complicated this disease.

The *symptoms* of gonorrhœa in women are sufficiently well marked in the early stages, when there is an abundant muco-purulent discharge from the parts affected, with a good deal of inflammatory irritation, accompanied with pain in micturition, and a frequent desire to pass urine. As the disease becomes chronic, however, it is more difficult to determine its true character; it being apt to be confounded with some of those accidental and leucorrhœal discharges to which females of all ages are subject.

Diagnosis.—In the majority of cases, gonorrhœa may be distinguished from all other *muco-purulent discharges* of the female organs, by the presence of inflammation about the external parts, and the mucous membrane of the vagina and urethra. In these cases it will be found, on introducing a speculum (which, however, occasions considerable pain, and is firmly grasped by the contraction of the vagina), that the

or nearly so; whereas in leucorrhœa the discharge proceeds in a great measure from the interior of the uterus, the os and cervix of which will probably also present signs of diseased action. It must, however, be borne in mind that the discharge in gonorrhœa may occasionally be in a great degree uterine; and that that of leucorrhœa may be an exudation from the mucous membrane of the vagina. In such circumstances, when the disease is chronic, it is almost impossible to arrive at a correct conclusion as to the nature of the case from simple inspection; and in these cases of doubt the surgeon had better give a very guarded opinion, lest he be led into the error of inculpating an innocent woman. The difficulty is increased, and a good deal of obscurity thrown over the case by the fact that leucorrhœal discharges will occasionally give rise to urethritis in the male, which closely simulates gonorrhœa. *Children* also are occasionally subject to an acute inflammation of the vagina and nymphæ as the result of simple irritation, of constitutional disturbance, or of teething; these cases require to be recognized, as they have frequently been the cause of unfounded accusations.

[Cullerier asserts that if vulvitis be found limited to the clitoris, it may be assumed to have been caused by masturbation; the inflammation from attempted rape or repeated coitus begins at the base of the labia minora and at the fourchette. This distinction would be of great importance in cases of medico-legal investigation.—A.]

The *treatment* of gonorrhœa in the female must vary, according as the disease is acute or chronic. In the acute stage, general and local antiphlogistic means—salines, low diet, rest in bed, and emollient sedative fomentations—must be used. As the disease subsides into a chronic condition, astringent injections must be employed; a weak solution of acetate of lead, or the liquor aluminis compositus largely diluted with tepid water, being especially useful. In other cases, a weak solution of nitrate of silver may be used with much advantage. These injections should be employed three or four times a day and in large quantity. After they have been thrown up, a piece of lint well soaked in the lotion should be introduced between the opposed mucous surfaces, so as to prevent their coming into apposition, the discharge being in a great measure kept up by their friction against one another. In order that the injection may be properly given, the woman should lie flat on her back, and pump in the fluid by means of one of Kennedy's elastic bottles. In the treatment of gonorrhœa in women, specifics are of no use unless the urethra be affected, when copaiba may be given, as in the male. The disease is apt to degenerate into a chronic gleety condition, leaving a thin muco-puriform discharge, which will continue to be infectious for a great length of time.

[Gonorrhœa in the female may conveniently be treated by means of medicated vaginal suppositories. Dr. J. J. Black, formerly of this city, has given a number of formulæ which have been successfully employed in the women's venereal wards of the Philadelphia Hospital. (*Am. Journ. of Med. Sciences*, July, 1865, p. 65.)—A.]

STRICTURE OF THE URETHRA.

Much discrepancy of opinion has for a long time existed as to the structure of the urethra, some surgeons admitting, others denying its muscularity. Though the presence of muscular fibres in the urethra had been suspected by many in consequence of the phenomena presented by some forms of stricture being solely explicable in this way, it is only in recent times that their existence has been demonstrated; Kölliker and Hancock having shown that the tube is surrounded through its entire length with an organic muscular coat. Hancock has demonstrated the course of these fibres. He has pointed out that the fibres of the inner layer of the muscular coat of the bladder pass forwards underneath the mucous membrane of the prostatic portion of the urethra, and those from the outer layer of the muscular coat of the bladder outside the prostate. These two layers join at the membranous portion of the urethra, forming the muscular covering of this portion of the canal. At the bulb these two layers divide again; the inner lying underneath the mucous membrane, separated from it merely by areolar tissue; the external lying outside the corpus spongiosum, between it and its fibrous investment. At the anterior extremity of the urethra, they unite again and form its lips. Thus the urethra is surrounded through its whole length by muscular fibres, a double layer of which invests it at the membranous portion, and again at the external meatus. The pros-

tate and corpus spongiosum are included between planes of these fibres. The vesicles and ducts of the prostate are surrounded by layers of organic fibre; those of the ejaculatory ducts coming from the organic layer of the vas deferens. These fibres are totally distinct from the common muscular apparatus of the perineum; and their existence proves the urethra to be, as had often been suspected, a musculo-membranous canal.

By *stricture of the urethra* is meant a narrowing of the canal at one or more points. These may proceed from three distinct conditions; viz.—1, spasmodic action of the layer of the organic muscular fibres situated outside the mucous membrane; 2, congestion of the mucous membrane of the canal; or, 3, organic changes in the mucous and submucous tissues, consisting of thickening, induration, or the deposit of plastic matter within them. According as the disease arises from one or other of these causes, it may be termed a *spasmodic*, a *congestive*, or an *organic* stricture. These different forms of the disease having the one condition—narrowing of the urethra—and its consequences, in common, and in practice being often associated together, present so much variety in their symptoms, in the treatment they require, and in the constitutions in which they occur, as to require separate description.

Spasmodic Stricture.—The existence of this form of the disease has been much cavilled at. Surgeons, disregarding the evidence of their own senses, and being led away by an imperfect anatomical examination of the urethra, have denied the possibility of spasm of this canal, not being able to demonstrate the existence of any muscular fibres in sufficiently close proximity to the mucous membrane to influence it by their action. The possession of muscular contractility by the urethra is, however, obvious from the facts that a bougie may occasionally be introduced with sufficient ease, but that the surgeon, on attempting to withdraw it, will find it tightly grasped; so also occasionally, on introducing the instrument, he will feel it meet with an obstruction, which on steady pressure will yield with that species of quivering that is peculiar to spasm of muscular fibre. Again, the fact that a patient will at one time pass his urine with the most perfect freedom, whilst, if it be rendered acrid or acid by drinking spirits, effervescent wines, or other similar beverages, almost complete obstruction will ensue, tends to prove the existence of an occasional spasmodic constriction of the canal. These facts, though sufficiently convincing to many surgeons, had failed to carry proof of the existence of spasmodic stricture to others, until the researches of Kölliker and Hancock, which have been referred to, set the question of the muscularity of the urethra finally at rest.

[The existence of spasmodic stricture is even now denied by no less an authority than Sir Henry Thompson, and while I would not go so far as that surgeon in declaring that the name is merely a cloak for want of skill, I confess that I meet with spasmodic strictures much less often than when I entered practice, and I believe the same to be the experience of others.—A.]

Causes.—The causes of spasmodic stricture are generally such conditions as occasion a relaxed and irritable state of system, as long residence in hot climates, especially if conjoined with habitual excesses in drinking, high living and venereal indulgences. The more immediate causes are usually any circumstances that occasion irritation of the urethral mucous membrane, which, being propagated to the organic muscular fibres beneath, calls them into activity and thus gives rise to the spasmodic affection. The most usual of these are those conditions of the system in which the lithates are largely eliminated; as exposure to cold and wet, by which the action of the skin is suspended; or too free an indulgence in spirituous and acid liquors—such as red or effervescent wines, beer, or punch—which are well known to give rise to an attack in many constitutions.

Symptoms.—In spasmodic stricture we find evidence of narrowing of the urethra, and consequent impediment to the free flow of urine, rapidly supervening under the influence of certain causes, and as speedily subsiding. A patient, for instance, in his ordinary health and passing urine freely, if he take such food or drink as will give rise to a very acid condition of this fluid; if he be exposed to cold, or get out of health in any way; suddenly finds himself able only to pass his urine in a small stream by drops with much straining, or may even be seized with complete retention. Under appropriate treatment these symptoms rapidly subside; recurring, however, on the application of any exciting cause. At the time of the occurrence of this spasm there is often a sensation of weight and uneasiness in the perineum, with evident irritation of the urethral mucous membrane, as shown by reddening of

the lips of the orifice: in fact, a tendency to a combination of the congestive with the spasmodic form of stricture. There will often be found to be a very slight *organic* stricture in cases of the *spasmodic* form of this disease; so that, when the spasm subsides, the urethra will not be quite so free as natural.

Treatment.—If the patient be suffering from spasmodic difficulty in passing urine, a suppository, consisting of a drachm of laudanum in a little starch, should be thrown up the rectum, the warm hip-bath used, and a full dose of Dover's powder administered. As the opium begins to take effect, the urine will usually be passed without much difficulty. The bowels should then be made to act, when the patient will usually be relieved. If the spasm continue, as it often does, for some days or weeks after this, a full-sized wax bougie should be introduced every second or third day, in order to lessen the irritability of the urethra. In some cases this is more effectually done by the use of a plated bougie, well warmed and oiled. Whatever instrument is used should be of large size, from No. 8 to 10. A small bougie will often be arrested, and will create much irritation, when a large one will pass readily. If the use of the instrument cause irritation and increase of spasm, it is better to omit it entirely, and to trust to constitutional treatment. But the surgeon must not be discouraged, if the first few introductions of the bougie appear to increase the irritation; as the urethra becomes accustomed to the use of the instrument, relaxation of the spasm will take place. At the same time the patient's general health should be carefully attended to; the bowels must be kept open, and the diet regulated; all acids, stimulants, and sweets, being carefully avoided. During the time when the bougie is being used he should take, three times a day, a draught composed of twenty minims of liquor potassæ, with the same quantity of tincture of henbane and sweet spirits of nitre, in camphor julep.

As a *preventive treatment* of these attacks, a careful regulation of the diet, warm clothing with the use of flannel, and keeping the skin in action by means of horsehair gloves and tepid baths, will be found serviceable.

Congestive Stricture.—Many surgeons look upon *spasmodic stricture* as essentially dependent on congestion of the mucous membrane of the urethra, overlooking altogether the existence of spasm, or considering it as the result of irritation of the perineal muscles, and not of the true organic muscles of the canal. That the two conditions of congestion and spasm are frequently associated in the urethra, in the relation of cause and effect, there can be no doubt; and this is the most frequent condition in which spasmodic strictures are found. Indeed, congestion plays an important part in all forms of stricture; it may, as we have just seen, be connected with the spasmodic variety; it may occur alone; or it may be associated with organic stricture. Some parts of the urethra appear to be more subject to congestion than others; thus, for instance, the membranous and prostatic portions, especially the folds of mucous membrane constituting the verumontanum, are peculiarly liable to become congested.

Causes.—Congestive stricture frequently occurs as the result of chronic and long-continued inflammation of the urethra, or of the passage of urine that has been rendered irritating by being too concentrated, or by an admixture of an undue proportion of lithates. It is especially in gouty or rheumatic subjects who suffer from irritability of the skin and mucous membranes that this condition occurs. In these cases there is no true or permanent obstruction, but the disease is transitory, and solely due to a swollen state of the membrane of the part.

Symptoms.—In congestive stricture we not only find the common symptoms occasioned by an impediment of the free passage of the urine, but some swelling of the lips of the urethra, with reddening and eversion of them. There is also slight gleety exudation, and not unfrequently an abundant puriform discharge, in fact, urethritis of a marked kind, with a sense of weight or fulness in the perineum, pain in micturition, and sometimes uneasiness in defecation. This state of things constitutes a very troublesome affection, intimately connected with the various forms of urethritis, and exceedingly apt to relapse from apparently very trivial circumstances, slight errors of diet, dyspeptic derangements, or any local sources of irritation.

The *treatment* in these cases should consist in careful regulation of the diet and habits of life, and especially in the administration of the alkaline and sedative mixture above indicated in combination with small doses of copaiba. In many cases a course of Plummer's pill, in conjunction with compound decoction of aloes, will be found of essential service. If there be much tenderness or weight about the peri-

hip-bath, will be serviceable.

Congestive stricture, though more influenced by constitutional than by local means in many cases, yet requires the introduction of bougies in order to prevent the constriction from becoming permanent. In some instances a wax, in others a silver or pewter instrument, will be found to answer best. Whatever is used, care should be taken to introduce it slowly and with every possible gentleness. With all care, some hemorrhage usually follows the passage of the instrument; not from laceration, but simply as the result of compression of the mucous membrane; and the discharge of blood appears rather to be beneficial than otherwise.

Organic Stricture.—This form of stricture is the result either of long continued inflammation of the urethra, leading to changes in the mucous membrane, or of some injury to the canal from blows or kicks in the perineum, by which a portion of it is destroyed or sloughs away. Repeated gonorrhœas and long continued gleets are the most fertile causes of this disease. In the urethra as elsewhere, plastic matter is deposited in and around the mucous membrane in the submucous areolar tissue, as the result of inflammation; consolidation of this takes places, followed by contraction of the canal. The long continuance of inflammation is more to be dreaded than its intensity in occasioning this mischief; hence it is of great importance not to allow gleets to run on indefinitely, as they will almost to a certainty be followed by constriction of some portion of the urethra.

Age.—Stricture of the urethra may be met with at any age after puberty. The causes that usually give rise to them seldom come into operation, however, before the adult age; hence strictures are not very common before 25 years of age. Between that period and the age of 40 they most commonly originate, and may then continue for an indefinite period. The earliest age at which I have seen true organic stricture of the urethra has been 14 years, when it had already been in existence for more than 12 months; it was situated about one and a half inches from the meatus, and was so tight as only to admit of No. 1 catheter. It was complicated with and had given rise to a fistula in perineo, through which the greater part of the urine escaped. The boy in whom it occurred could give no explanation of its occurrence. His attention was directed to it in the first instance by a sudden attack of retention. The stricture was hard and gristly, about half an inch long, and required urethrotomy for its relief.

[I once saw a case of traumatic stricture, followed by urinary extravasation and death in a child of only eleven years. Dr. Charles C. Lee, of New York, has published an account of the case (*American Journal of Medical Sciences*, July, 1862, page 108).—A.]

Seat.—The seat of organic stricture varies considerably; indeed, any portion of the urethra may be affected by it, except the prostatic. It appears to be the common belief amongst surgeons, that the membranous portion of the canal is the most frequently affected by this disease. This, however, there can be but little doubt, is an erroneous opinion. H. Smith has examined 98 specimens of stricture contained in the different London museums; of these he found only 21 seated in the membranous portion of the urethra, whilst 77 were anterior to the triangular ligament; the majority of these being either in the bulbous portion of the urethra, or a little in advance of this. Thompson, in his excellent work on *Stricture*, states as the result of his numerous observations, that stricture is more frequently met with at the junction of the spongy and membranous portions of the urethra; next, about one inch anterior to this; and most rarely, so far back as the membranous portion itself; lastly, he states, "I can confidently assert that there is not a single case of stricture in the prostatic portion of the urethra to be found in any one of the public museums of London, Edinburgh, or Paris." Not unfrequently strictures are met with at the mouth of the urethra; and occasionally they are multiple, two very frequently occurring, and sometimes as many as four or five. When there are several strictures, one will always be found at the bulb or in the membranous portion of the urethra.

Characters.—The characters of organic stricture vary greatly. In some cases it is annular, encircling the whole of the canal, and occasionally for some little distance. The elongated annular stricture usually arises from consolidation of the corpus spongiosum by plastic matter compressing the urethra, as in Fig. 581. In other cases, again, annular strictures may be narrow and sharp-edged, and are then called

lated. The *ureters* are often found dilated, from a tendency to a reflux of th
or to compression of their vesical orifices, in consequence of the altered
of the bladder. The *kidneys* become irritated, congested, and at last
some of those various structural changes which, by impairing their fun
interfering with the proper depuration of the blood, may eventually
patient.

Symptoms.—The amount of constitutional disturbance set up by
vary greatly in different cases. In many, and indeed in most ins
very great. The extent to which the constitution is influenced wi
proportion to the tightness and duration of the stricture; but it
much constitutional irritation is set up in some systems by a str
it be not very tight. The interference with the free flow of the
tion of the bladder and kidneys, the secretion from which b
than usual; in consequence of this, the actions of the skin
organs are deranged, and thus the system at large is infl
other cases, again, the constitutional symptoms are rather
the patient suffering not only great pain in micturition, bu
followed by nervous prostration, each time the urine flo
table surface.

The *local signs* of stricture are always well marke
are dependent simply on the mechanical obstacle prese
to the free escape of the urine. The disease usually
of a few drops of urine after evacuation of the
patient finds that he has to pass urine more frequ
night; there is some straining, perhaps a slight
weakness about the genital organs. The strean
upon it during its passage through the strictu
are modified; thus, it may become forked, s
charged in a double current—one projected
perpendicularly downwards. As the diseas
come more marked, until they may termina
often come on in a very insidious manner,
found to be already the subject of a very
some cases, the first circumstance that
complaint is the sudden occurrence of

Examination of the urethra.—The
certainty only by the introduction of
ing the canal in a suspected case, t
of stricture, and its degree of tight
mined by passing a plated steel s
No. 8, well oiled and warmed.
point, but will then be arrested.
not be used, lest it hitch in the
and this accidental arrest be m
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factorily determined. The ultimate result of the cases in which it has been practised has not as yet been fully laid before the profession; and, until this has been done, we cannot consider the utility of the operation as established, except as a means of temporary relief in cases of the kind just mentioned. Much will certainly depend upon keeping up dilatation of the urethra for some months after the division of the stricture, a catheter of full size being passed once in a week or ten days. If this precaution be neglected, relapses will often occur: and even when it is scrupulously attended to, they are, I believe, by no means unfrequent. Against urethrotomy it has been argued that, like a wound, the incision into the urethra might occasion a cicatrix which would contract, and thus eventually tend still further to lessen the diameter of the canal. But *post-mortem* examination of patients who have died some years after this operation had been performed has shown that the idea is groundless, the cicatrix being linear and scarcely perceptible. In fact, there is a great difference in the result, between cases in which the urethra has been divided transversely and those in which it has been incised longitudinally. In the first instance, a dense and contractile cicatricial mass is formed; in the second case, a linear and scarcely perceptible scar.

Comparison of methods of treatment.—The most important question in connection with the several operations is, in what class of cases they should be practised. That most strictures may be cured by gradual dilatation, there can be no doubt; most practitioners holding with Liston, that, whenever a catheter will pass through a stricture, its cure by dilatation is certain, in the hands of a skilful surgeon. Though this may be generally true, instances not unfrequently occur, in which simple dilatation fails to effect a cure; the stricture being highly contractile, and not allowing expansion beyond a certain point, or relapsing whenever the dilating means are removed. In other cases, also, the patient suffers so much pain and irritation whenever an instrument is passed, that he cannot bear the repeated introductions that are necessary, more particularly if the stricture be complicated with fistulæ in perineo or false passages, which render its cure by dilatation, tedious and almost impracticable. In such cases as these the surgeon, being unable to benefit his patient materially by dilatation, must choose between the employment of palliative means or more active measures.

It appears to me that there are four classes of cases, in which more energetic means than simple dilatation may not only be advantageously employed, but are absolutely required.

1. *Very old dense cartilaginous strictures*, often of traumatic origin, which admit an instrument with great difficulty, and cannot be dilated beyond a certain point, owing to the conversion of the urethral structures into a kind of dense, fibrous, almost cicatricial tissue, which neither admits of expansion nor of absorption by the pressure of instruments; and in which a considerable extent—half an inch or more—of the urethra is involved.

2. The same kind of stricture, complicated with *fistulæ* in the perineum or scrotum, with perhaps considerable plastic infiltration of these parts. In both these classes, I think that the perineal section or external urethrotomy is the preferable operation.

3. Very *tight strictures*, accompanied by *excessive sensibility* of the urethra; in which each introduction of the instrument is attended by intense suffering, spasmodic movements of the limbs, and rigors, so that the patient cannot be induced to submit to a proper course of bougies.

4. Very *elastic*, though perhaps *narrow strictures*, that can be dilated readily enough, even up to the admission of full-sized instruments; but which, when the treatment is discontinued, immediately begin to contract again, so that the patient is never out of the surgeon's hands, and sees no prospect of cure.

In these last two classes of cases, I am of opinion that internal urethrotomy with Civiale's instrument, or the forcible expansion or rupture of the stricture, is the best method of treatment; the perineal section being too severe and dangerous, whilst simple dilatation is too feeble a means of treatment.

Impermeable stricture.—In order to perform the perineal section, the stricture must be pervious to a grooved staff, however small this may be; and this, it might

be supposed, would limit materially the cases in which the operation can be performed. But complete obliteration of the urethra cannot take place except as the result of sloughing, usually from injury; indeed "impermeable" strictures, though frequently spoken of, are very rarely met with. Syme, indeed, denies their existence, and states that, if urine can escape through a stricture, a bougie can be introduced. A surgeon may often be foiled in his first attempts in passing an instrument through a very tight stricture; but I believe that, with patience, by attention to constitutional treatment, so as to lessen urethral irritation, and especially by the administration of chloroform, he will usually at last succeed in making an instrument of some kind pass through the very worst strictures. In the very first case in which I performed the perineal section, almost all the urine had for twelve years been discharged through fistulous openings in the perineum and scrotum; and the principal portion escaped through a large hole on the inside of the left thigh, a few drops merely occasionally passing out by the lips of the urethra. No instrument had been passed for four years, though repeated attempts had been made by different surgeons. Being foiled in introducing a catheter into the bladder the first time I tried, I kept the patient in the hospital for two or three weeks, attending carefully to his constitutional condition, but without making any further effort. He was then placed under chloroform, when I succeeded in passing No. 1. The urethra was then dilated up to No. 5, beyond which no instrument could be passed, when the perineal section was performed. The patient made an excellent cure, the fistulous openings closing, and the urine being discharged by the natural channel. In another case, which I attended with Mr. Bryant, persevering attempts had been made for five years to make an instrument enter the bladder, but without success, the stricture not only being excessively tight, but the urethra acutely sensitive; under chloroform I succeeded in introducing No. $\frac{1}{2}$ silver catheter into the bladder, and speedily cured the patient.

The influence of *anæsthetics* in facilitating the passage of instruments through apparently impermeable strictures is very marked. Shortly after the introduction of ether as an anæsthetic agent, Liston was going to cut through a stricture that had resisted all attempts made by his most dexterous hand at introducing an instrument into the bladder; but no sooner was the patient put on the table and fairly rendered insensible, than the No. 8 silver catheter, which had been passed down as far as the stricture, and the point of which was to serve as a guide to the knife, slipped into the bladder, and thus rendered a dangerous operation unnecessary.

Yet no surgeon can doubt that cases do occasionally, though rarely, occur, in which, in consequence of extravasation of urine and old inflammatory action, the urethra has become so tortuous and narrow, and the perineum so indurated and disorganized, that an instrument cannot be passed through, even though the urine pass out readily. It must be borne in mind that a stricture may be permeable to urine, but impermeable to a catheter, even in the most dexterous hands. It does not follow necessarily that because a fluid will trickle out of a narrow and tortuous channel, a catheter or solid sound can be passed into it from without. In a case of extravasation of urine following stricture, consequent on injury of the perineum, sent to me by Mr. Corrie of Finchley, in which no catheter had been introduced for eight years, it was found after death that, although the urethra had been converted into a mass of cicatricial tissue at the part injured, it was yet permeated by a narrow tortuous passage, through which the urine had escaped.

Hence cases will occasionally occur, in which the perineal section is not practicable. In the event, therefore, of a stricture being so tight and tortuous that no instrument will pass through it, or where, a portion of the urethra having sloughed away, its canal is obliterated, neither the cure by dilatation nor urethrotomy can be performed, and it may then be necessary to have recourse to incision of the stricture without a guide.

Operation for impermeable stricture.—This operation is performed as follows. A No. 8 silver catheter is passed down to the stricture; the patient is then tied up as if for lithotomy; and the surgeon, sitting in front, pushes a bistoury with the back turned towards the rectum into the raphe of the perineum as far as the apex of the prostate, so as, if possible, to open the dilated urethra *behind* the stricture. He then cuts *forwards* through the stricture on to the point of the catheter, and, having thus opened a passage, endeavors to pass that instrument on into the bladder. It is often extremely difficult to find the posterior part of the urethra; but in some

cases this part of the operation may be facilitated by passing a grooved director or straight female catheter into it to act as a guide. When the tissues of the perineum are hard and gristly, altered by the effusion of plastic matter, and condensed by repeated attacks of inflammation and the existence of fistulæ, it is a most difficult matter to dissect through such an altered mass and hit the urethra beyond it; and the difficulty is still further increased by the bleeding, which is often profuse.

This operation, I have no hesitation in saying, is perhaps the most troublesome in surgery. I have more than once seen the most skilful operators foiled in their endeavors to accomplish it, and compelled to relinquish the operation without concluding it, or only succeed after prolonged and most painful attempts. Fortunately this operation is now scarcely ever necessary; with patience and under chloroform the surgeon may almost invariably pass a staff, however small, into the bladder; he then has a sure guide upon which to cut, by following which he must certainly be led through the stricture into the urethra beyond it. In all cases, therefore, urethrotomy should, if practicable, be substituted for the division of the stricture without a guide.

[I have performed the operation of perineal section without a guide upon three patients, with but one death, and that from visceral disease, which existed at the time of the operation. The plan which I have followed, and which is, I believe, generally employed in this country, is to cut down directly upon the point of the staff or catheter, and then to work cautiously backwards in the median line until the stricture is divided and the healthy urethra reached behind.—A.]

COMPLICATIONS AND RESULTS OF STRICTURE.

Retention of Urine.—This has a tendency to occur in all tight strictures from the gradual and progressive contraction of the canal. It most usually, however, takes place in consequence of a congestive spasmodic condition being superadded to the organic constriction. It commonly happens that a patient having a moderately tight organic stricture commits an excess, or becomes exposed to cold and wet, and thus gets such a congested condition superadded, that the urine will not pass at all, or only in such small quantity by drops, and with so much pain and straining, that the bladder cannot be completely emptied. In these cases the retention always eventually becomes complete; the bladder speedily fills, and rises above the pubes; there is much distress and constitutional disturbance; and, if relief be not afforded, the distended portion of the urethra behind the stricture will ultimately give way, and extravasation of urine ensue. In these circumstances, it becomes imperatively necessary to empty the patient's bladder as speedily as possible.

Treatment.—This varies with the severity of the symptoms and irritability of the patient. If the retention have not continued very long, and if the patient be not very irritable, an endeavor might be made at once to give relief by passing a small catheter into the bladder. In this the surgeon may often succeed more readily than might have been expected, the stricture frequently yielding before an instrument, more easily when there is retention than when this condition does not exist. Even if the catheter do not enter the bladder, its point or that of a catgut bougie merely being introduced well into the stricture, it will generally happen, as Brodie has pointed out, that, on the withdrawal of the instrument, the urine will follow in a full stream; but if a sufficiently small catheter be used (in many cases not larger than half of No. 1 is admissible), the instrument may usually be made to fairly enter the bladder. If the patient be very irritable it is better, before attempting the introduction of the instrument, to give him an opiate enema of a drachm of laudanum in about two ounces of starch, and to put him into a warm hip-bath; the introduction of the catheter may now be attempted, and will very generally succeed. Should it still fail, the effect of the inhalation of chloroform should be tried, when it almost invariably may be made to pass without the employment of any great or dangerous degree of force. There are no cases in surgery in which chloroform is of more value than in these; under its influence it is seldom, indeed, that the catheter will not pass. After the instrument has been passed into the bladder it should be left there, being tied in by means of tapes passing from its rings under the patient's thighs, to a bandage that is passed round his waist. Antiphlogistic remedies must then be employed in rather an active manner; a free purge, leeches to the perineum if there be tenderness in this region, and salines with antimony. The catheter will

be found to be loosened at the end of forty-eight hours, when it should be withdrawn, and the cure by dilatation proceeded with in the usual way.

If, however, the surgeon be unable to introduce a catheter in the ordinary way through the stricture, relief must be given to the over-distended bladder in some other way, lest it or the urethra burst, and extravasation of urine occur. The bladder may be emptied in four ways: 1, by forcible catheterism; 2, by making an opening into the urethra behind and through the stricture; 3, by puncturing the viscus itself through the rectum; and 4, by puncturing it above the pubes.

1. *Forcible catheterism* is a most unsurgical and dangerous procedure. Nothing can surely be more improper than to take a small, stiff, silver catheter, pass it down to the stricture, and then, by main force, attempt to drive it on into the bladder. In these cases the surgeon usually fails in his attempt at reaching the viscus, but pushes the point of the instrument into the tissues around the neck of the bladder or the prostate, and thus induces great, and perhaps even fatal, mischief in these regions. If he should, by some fortunate accident, reach the bladder, it is not by any skilful though forcible expansion of the stricture, but rather by perforating the urethra, and burrowing through the corpus spongiosum and prostate—"tunnelling," as it has been termed—until he again enter that canal, or in some such way reach the neck of the bladder.

2. *Opening the urethra behind and through the stricture.*—In the kind of retention of urine that we are now discussing, the safest, though by no means the easiest mode of affording relief after the failure of the catheter, is to make an incision into the middle line of the perineum, and to open the urethra behind or through the stricture. In doing this there is much less difficulty in cases of retention, than when the bladder is empty. In consequence of the urethra being distended by the accumulation of urine, and by the straining of the patient, it sometimes attains a considerable magnitude; though, if this be not the case, the operation may prove a very serious and difficult one. The operation, which is essentially the same as that for impermeable stricture, described at p. 1128, is performed by passing a catheter down to the stricture; opening the distended sinus of the urethra *beyond* this; cutting upwards through the stricture upon the end of the instrument; and then passing the instrument on into the bladder, or allowing the urine to flow from the aperture thus made in the perineum. In doing this, care must be taken to keep strictly in the direction of the mesial line, so as not to wound vessels of importance. One advantage of this operation is, that the stricture may by it be cured at the same time that the retention is relieved; and, as the incisions do not extend into the bladder, but are limited to the urethra, there is less danger to the patient than when that viscus is opened.

Another advantage of the perineal incision in these cases is, that it not unfrequently happens that urinary abscess has begun to form, or the extravasation of a few drops of urine has taken place sooner than the surgeon may have had any idea of: and if so, the incision through the perineum will afford an exit for any extravasated matters, at the same time that it relieves the patient from the distress and danger of the retention. Should any mischief of this kind have taken place, it is not necessary to be so particular about opening the urethra with the knife; for, an aperture having already been established in it, the urine will readily flow through the artificial channel thus formed by free incision into the inflamed or suppurating perineum.

3. *Puncture of the bladder through the rectum.*—After emptying the bowel by means of an enema, the surgeon passes the left index-finger well into the gut, feeling for the posterior margin of the prostate; he then carries the trocar and canula, which are long and somewhat curved, upon this as a guide, and, when the extremity of the instrument has reached the posterior edge of the prostate, he pushes it upwards into the bladder (Fig. 580, *b*.) [As the bladder is a very mobile organ and might readily be pushed before the trocar, it should be steadied by the hands of an assistant upon the abdominal walls.—A.] The seat of the puncture between but in front of the ureters is well shown in Fig. 591, which represents the bladder and strictured urethra of a man who died some days after this operation had been performed for retention from stricture. In performing this operation, the surgeon perforates the bladder in that portion of its fundus which is uncovered by peritoneum, being bounded behind by the reflection of the serous membrane, anteriorly by the prostate, and on each side by the vesiculæ seminales. In order to avoid

rectum, the surgeon should withdraw the point of the stylet into the canula, so as to avoid wounding the gut, and not push it forwards until he has the end of the canula fixed against the spot where he intends to make the perforation. After withdrawing the stylet and emptying the bladder, the canula should be tied in by means of tapes, and left for a few days until urine begins to pass by the natural channel, or until means can be taken to restore the passage through the stricture, when it must be withdrawn and the aperture left to close. In consequence of the irritation of the urine being removed from the urethra, a catheter may often be passed a few days after the operation; and the stricture will readily yield to dilatation in the ordinary way.

Fig. 591.

Seat of puncture through rectum in a case of stricture.

This operation has the advantage of being far easier of performance than the last, and may doubtless occasionally be required in those very rare cases of retention from stricture in which there is no sign of abscess or extravasation in the perineum, in which the urethra appears not to be dilated behind the stricture, in which the prostate is not enlarged, and in which, under chloroform, and with patience, a catheter cannot be passed into the bladder; a combination of circumstances that will but very rarely indeed occur to a surgeon skilled in the use of his instruments.

The operation of puncture through the rectum is not devoid of danger; urinary infiltration, and pelvic inflammation and abscess, may result from it. In a remarkable case that was under my care at the hospital (in 1859), a sequence occurred which I have never seen noticed, viz., the diffusion of rectal flatus through the areolar tissue of the pelvis and down the thighs and nates, producing an emphysematous condition of these parts and the death of the patient. The case was briefly as follows. A middle-aged man had suffered from traumatic stricture for very many years—indeed, from childhood. He was admitted with retention. As no catheter ever had been or could be passed, I punctured the bladder by the rectum in the usual way. The canula was removed on the fifth day. He then passed urine *per urethram*, and continued to do so up to the time of his death. The day after the withdrawal of the canula he felt very ill, but without any positive or tangible complaint. The next day it was found that the back and inner part of both thighs were emphysematous and crackling, evidently distended with air. The emphysema extended downwards and also up the flanks, and appeared even in the right arm. There was no pain nor discoloration. He died on the following day, the eighth after the puncture. After death no trace of pelvic inflammation, suppuration, or urinary extravasation was found; but there was much infiltration of gas under the pelvic peritoneum, and in the areolar tissue between the bladder and rectum. The gas had probably passed through the sciatic notches into the posterior parts of the thighs. It was fetid, like intestinal flatus.

4. *Puncture of the bladder above the pubes*, in cases of retention from stricture, is but seldom resorted to; although some surgeons of eminence, more especially Paget of Leicester, have strongly recommended and often practised it. This operation, which has been discussed at p. 1102, is undoubtedly easy of performance, and sufficiently safe, though not devoid of the danger of infiltration of urine into the tissues around the puncture, and of the inconvenience of a fistulous opening being left. There is one class of cases to which it appears to be especially applicable, and in which I have had occasion to practise it, viz., those cases of retention from impassable stricture, in which there coexists an enlargement of the prostate, rendering the perineal section dangerous, and puncture through the rectum impossible, the surgeon's finger not being able to reach beyond the enlarged prostate; and here undoubtedly the safest, if not the only course to pursue, is the supra-pubic puncture.

After the bladder has been punctured, by whichever of these methods the surgeon may think proper to adopt, means must be taken to restore the calibre of the urethra, so as to prevent the orifice of the puncture from degenerating into a permanent

fistulous opening. With this view the canula should be left in the bladder, and the urine allowed to discharge through it for from four to six days. At the expiration of this time, should no urine have passed by the urethra, the stricture in the canal will be found to be relaxed, and a small instrument may usually without much difficulty be introduced into the bladder, where it should be retained, the canula being withdrawn. The cure of the stricture by dilatation may then be proceeded with in the usual way.

Extravasation of Urine.—In consequence of the ulceration or disorganization of the coats of the urethra, this canal may give way behind the stricture, and the urine become infiltrated into the surrounding tissues. The part of the urethra that gives way is invariably the membranous portion of the canal, just anterior to or between the layers of the triangular ligament, where it is weak, being least supported by surrounding structures, and usually most dilated and attenuated by the pressure to which it has been subjected. This circumstance is a strong argument in favor of the opinion that stricture of the urethra never occurs at or behind the deep perineal fascia; did it do so, we should necessarily find extravasation of urine in a deeper situation than we do. Were it possible for the urethra to give way altogether behind the deep perineal fascia, the urine would become effused into the cavity of the pelvis. But, as it is, the connection of the triangular ligament with the rami of the pubes and the ischium prevents the extension of the infiltrated urine in that direction; and the manner in which the superficial fascia of the perineum is connected with the deep fascia uniformly causes the fluid to take a course forward into the perineum, scrotum, and upwards upon the external organs of generation, the groins, and the anterior abdominal wall: so that it ascends contrary to its gravity rather than soaks back into the more dependent parts of the body, as it would do, were it not for the particular connection of the fasciæ that has just been alluded to. I have, however, known the superficial fascia to give way, and the urine, then gravitating backward, to give rise to extensive sloughing in the ischio-rectal fossæ and about the nates, denuding the rectum.

Local effects of extravasated urine.—The effects of urine that has become acrid and concentrated by long retention, are most deleterious upon those tissues with which it comes into contact. The vitality of whatever portion of areolar tissue it infiltrates is immediately destroyed; the tissue becoming converted into a kind of putrid stringy slough, intermixed with and soddened by a quantity of fetid dark-colored acrid pus and urine. The ravages of extravasated urine are often extensive; the urethra giving way suddenly behind the stricture, the fluid is driven with all the force of the vital and physical contractility of the over-distended bladder into the perineum, and thence rapidly finds its way through the scrotum upwards. In other cases, again, the extravasation occurs more slowly; a few drops appear first of all to escape from the urethra through a small rent or ulcer in it; these give rise to inflammation in the surrounding structures, by which the progress of the extravasation is for a time limited. It is especially upon the areolar tissue of the scrotum that the effects of the extravasation manifest themselves in their full intensity, causing great distension and rapid sloughing of it. The skin speedily participates in this action, becoming of a dusky-red or purple color, and then falling into a state of gangrene. In this way the testes may become denuded, and the cords exposed. It is remarkable, however, if the patient survive these destructive effects, with what rapidity reparative action goes on in this region. It is seldom that infiltration extends higher than the groins, or the anterior portion of the abdominal wall; but it may reach the costal cartilages before proving fatal.

When the extravasation is deep, the urethra being opened between the layers of the triangular ligament, the patient, after suffering from retention, experiences a sensation of relief, and as if something had given way in the perineum, followed after a time by throbbing and pain. There may be but little swelling for a day or two, but then a doughy red diffused intumescence takes place in the scrotum and rapidly extends forwards. When the rupture is altogether anterior to the deep perineal fascia, then rapid swelling and infiltration, partly urinous, partly inflammatory, take place in the scrotum and penis; these parts become enormously distended, œdematous, crackling, and emphysematous, with the local signs that have already been mentioned.

The *constitutional disturbance* is always considerable; at first it is of an irritative

possible. This should be done, as soon as the extravasation is known to have occurred, by a deep incision into the middle of the perineum. So soon as any pain and throbbing, with diffused swelling, occur in the perineum, with redness and more or less œdema of the scrotum, the patient should be drawn to the end of the bed and placed in the position for lithotomy. The surgeon should next introduce his left index-finger into the rectum, so that the gut may not be wounded, and then, pushing a long sharp-pointed bistoury deeply in the raphe of the perineum, cut upward to a sufficient extent into the extravasation, and in the direction of the urethra. A catheter should then, if possible, be introduced, secured in the bladder, and left unplugged; in this way no further effusion can occur, an outlet will be afforded to matters already effused, and the greater part of the urine will commonly be found to escape after a time by the aperture thus made. Should the case not be seen until extravasation has spread widely, a free incision should not only be made into the perineum, extending to the aperture in the urethra, but also into the scrotum on each side of the septum, into the penis, and wherever else swelling is observed. The sole chance of safety for the patient lies in making these free incisions, through which the parts may, to a certain extent, empty themselves. However extensive the infiltration and serious the mischief may be, we need not despair of the patient if a free outlet can be obtained for the acrid and putrescent urine and effused matters; and in order to secure this, the infiltration must be followed by incisions as high as it extends. The parts must, at the same time, be covered with chlorinated and yeast poultices; and the constitutional powers of the patient must be supported by good nourishment and a sufficient supply of stimulants.

If the patient survive the immediate impression upon the system produced by the gangrene and the urinary infiltration, he must be prepared to go through a severe trial to his constitutional powers, in the separation of the sloughs, the profuse discharge, and other sources of irritation that are set up. During this period he will require abundant support; the brandy-and-egg mixture, ammonia and bark, with any nourishment that he can take; and much attention should be paid to the removal of the sloughs, to giving a ready outlet to the discharges, and to keeping the patient as clean and as free from all local irritation as possible.

Urinary Abscess may be considered in many cases as a limited effusion of urine mixed with pus, and circumscribed by plastic matter that is deposited in the tissues with which the urine comes into contact. It is generally occasioned by the irritation of the passage of instruments, but may arise simply as the effect of stricture, or from inflammation of some of the urethral follicles. From some cause of this kind a small abrasion or aperture forms in the urethra, a drop or two of urine escapes into the subcutaneous areolar tissue, and this becomes bounded or circumscribed by plastic deposit around it, so that extravasation does not occur. Such an abscess as this may form at any part of the urethra; but it is most frequently met with in the perineum, appearing to take its origin from the bulb or membranous part. It is rarely dangerous, but is chiefly of consequence by being commonly followed by urinary fistula.

Symptoms.—An urinary abscess is indicated by the formation of a small, somewhat circumscribed, hard, and painful tumor, situated in the neighborhood of the urethra. It is usually unattended by constitutional disturbance; unless it attain any considerable bulk, when some pyrexia may ensue. It is principally in the perineum that it attains any degree of magnitude, then constituting a perineal abscess, characterized by a deeply seated, hard, tense tumor, brawny and without fluctuation; attended by considerable weight and throbbing in this region. It does not readily point, owing to the manner in which it is bound down by the superficial fascia.

Treatment.—Early incision is required. When the abscess occurs in the scrotum or anterior to it, the surgeon should wait for fluctuation; but when it is seated in the perineum, he need not do so, but should at once make a free incision through the mesial line into the hard brawny mass, which must then be well poulticed.

Urinary Fistulæ commonly form in the perineum and scrotum as the result of abscess in these regions communicating with the urethra; occasionally, however, they are met with in other situations, as in the groin, the anterior abdominal wall,

or the inside of the thigh. They usually communicate with the bulb or with the membranous portion of the urethra, but occasionally occur anterior to this. In number they vary considerably; when occurring in the scrotal and penile portions of the urethra, they are usually single; but when in the perineal, they are often rather numerous; several apertures being occasionally met with about the perineum, scrotum, and nates. In one case Civiale found as many as fifty-two. Their size also differs considerably; some only admitting the finest probe, whilst others are large cloacæ. In a case under my care, the patient had a tunnel of this kind in the groin that would readily admit three fingers. They are usually tortuous, elongated, and narrow; sometimes constricted externally and more widely dilated behind. The surrounding parts are greatly condensed; the whole of the scrotum and penis is enormously enlarged, indurated, and almost cartilaginous in structure. The urine may escape almost entirely through the fistulæ, scarcely any being discharged through the urethral orifice; or there may be but a slight exudation from the fistulous openings.

The *treatment* of urinary fistula varies according as it is complicated with stricture, and as it is situated in the anterior or posterior parts of the canal.

If there be a stricture, this, as the cause of the fistula, will require removal either by dilatation or by the perineal section. If the stricture be not very tight and hard, dilatation commonly succeeds; the instrument being introduced every second or third day, until the urethra is dilated to its normal size, when the fistulous tracks will in many cases close. In some instances, however, the frequent introduction and withdrawal of the catheter is a source of irritation, and then it had better be left in. When this practice is adopted, a moderate-sized elastic catheter should be used. If this be too small, the urine will flow between it and the sides of the urethra, and thus escape through the fistulæ; if too large, it stretches the urethral orifice of the fistula injuriously.

[Whatever be the size of the instrument, urine will escape aside of it as well as through it if it remain in the urethra, and hence it is often better to teach the patient the use of the catheter, so that he may draw off his own water whenever it may be necessary and thus make sure that none will enter the fistula.—A.]

If the fistula be very tough and irritable, the better plan is to perform urethrotomy at once, as much time and pain are thus saved. In the majority of instances, internal urethrotomy with Civiale's instrument appears to me to be the safest and simplest procedure, and I have very advantageously practised it in such cases. But if the fistulæ be very numerous, so as to riddle the perineum and scrotum in all directions, perhaps the better plan is to perform the perineal section. In this way we not only divide the stricture, and thus at once remove all obstruction, but give a free exit to the urine, which, instead of escaping by tortuous and sinuous passages, finds its way out readily through the new aperture that has been made, which will eventually granulate and heal by the second intention.

The fistulæ, especially if small and recent, will sometimes heal kindly enough after the removal of the obstruction; but if extensive, old, and cartilaginous, they are of course little disposed to take on reparative action; and, although the cause that in the first instance gave rise to them may be removed, yet they constitute an independent affection which requires special treatment.

The special treatment for urinary fistula must vary according to the size of the canal, but more particularly with regard to the part of the urethra with which it communicates; whether it be a *perineal*, a *scrotal*, or a *penile* fistula.

If the fistula be *perineal*, and of small size, a probe coated with melted nitrate of silver, or a wire made red-hot in the ordinary way, or by the galvanic current, and passed down it occasionally, may cause its contraction. If it be large, a gum-catheter should be kept in the bladder, and the edges of the fistula freely rubbed with the nitrate of silver, or deeply pared and brought together by quilled sutures. If the fistulæ be large and very numerous, it will be better to pass a grooved director down the principal ones, and slit them up so as to throw the several sinuses into the larger one.

When the fistula is *scrotal*, it often requires to be laid open, and to be made to granulate from the bottom, when it may be found to communicate with large sloughy and ill-conditioned cavities in this situation.

When *penile*, the fistula is usually much more troublesome to heal; its edges are thin, and the track is short and shallow.

Urethroplasty may in such cases be advantageously practised. Operations of this kind require for their success very careful management and minute attention to detail; they very commonly fail in consequence of a small quantity of urine or of mucus escaping through the wound, and thus interfering with union of its lips.

In order to prevent this accident, which is fatal to the success of the operation, the patient should be taught to pass a catheter, and thus to draw off his own urine after the operation as often as necessary; or an assistant must do this every third or fourth hour. Should this, however, not be practicable, a full-sized gum-catheter should be passed into the bladder and properly secured there. It should be left without a plug, so that no distension of the bladder and consequent likelihood of escape of urine between the urethra and the instrument may take place. In order to prevent urinous effusion over the integument of the penis and scrotum, a vulcanized India-rubber tube should be attached to the end of the catheter, by which means the flow of the urine is directed away from the patient.

Urethroplastic operations may be varied according to the seat and extent of the fistulous opening.

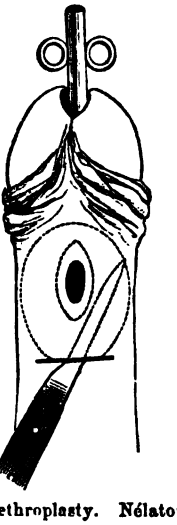
If the fistula be in the *perineum*, the parts around being thickened and indurated, its closure may often be attained by freely and deeply paring the edges, and then bringing them together with the quilled suture, or by Sims's button.

When the fistula is *scrotal*, the edges should be freely pared, and the parts around widely dissected up so as to form large and thick flaps of cellulo-cutaneous tissue, which may be brought and held together by metallic sutures or shotted clamps. In this way, if union be not obtained throughout the whole length of the fistula, it may be to a partial extent; and, after a time, a second or third operation will complete the cure.

When the fistula is *penile*, the difficulties in effecting closure become immensely increased. This is owing to the thinness of the integumental structures and the absence of subcutaneous areolar tissue in this region, so that there is not sufficient thickness of the parts for ready plastic union. In these cases the surgeon has a choice of four operations.

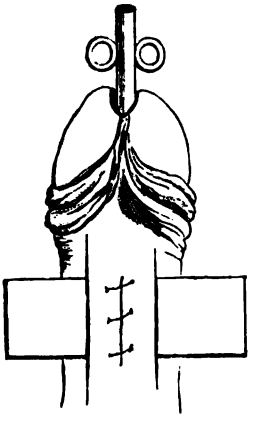
1. Nélaton has recommended the following procedure. The edges of the fistula having been pared, the skin around, to the extent of about an inch, should be dissected up subcutaneously through an opening made below the fistula, the edges of which must then be brought together by a few points of suture. The displacement of the skin covers in the aperture in the urethra, and causes granulations to spring up, by which the fistula is closed (Figs. 592, 593).

Fig. 592.



Urethroplasty. Nélaton's operation: First stage.

Fig. 593.



Urethroplasty. Nélaton's operation: Second stage.[1]

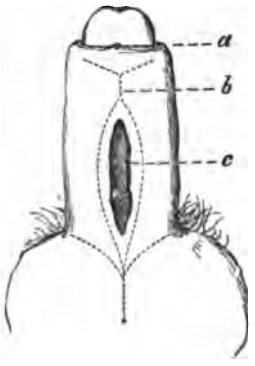
2. The edges of the fistula having been pared and the skin separated widely, lateral incisions may be made so as to take off all tension, and a slip of India-rubber may then be passed underneath the flaps of skin in order to prevent contact of the urine from disturbing the adhesions.

3. Le Gros Clark has recommended and successfully practised the following operation. Having pared the edges of the fistula, he makes a transverse cut through the integuments of the penis, about an inch in length, above and below it. He then dissects up the flaps of skin so bounded, and brings them together by means of

[1] [This wood-cut, though described as illustrating Nélaton's method, appears really to be designed as an illustration of the second operation described in the text.—A.]

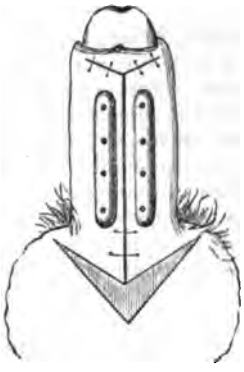
clamps or the quilled suture. By this operation a wide raw surface from each side is brought into contact, instead of a mere raw edge of cut integument, and there is consequently a greater chance of successful union resulting (Figs. 594, 595).

Fig. 594.



Urethroplasty. Clark's operation; First stage.

Fig. 595.



Urethroplasty. Clark's operation: Second stage.

4. Ricord, recognizing the fact that the occasional intrusion of a drop of urine between the freshened edges of the integuments brought together to close the fistula has been the most common cause of disunion, has recommended that, in those cases in which a perineal or scrotal fistula happens to coexist with a penile one, a catheter should be passed through the former into the bladder, and left there during the whole of the operative procedures that are adopted for the closure of the penile fistula. Should no fistula exist in the perineum, he has proposed, though I believe the operation has never yet been practised, to puncture the bladder—which would most conveniently and safely be done through the rectum—and to keep it emptied in this way until the penile fistula has been closed by one of the preceding operations, and then to allow the lower aperture to close spontaneously; or, if it were situated in the perineum, to adopt surgical means for its occlusion.

URINARY VAGINAL FISTULÆ.

Preternatural communications between the urinary passages and the vagina commonly arise from injurious pressure upon and consequent sloughing of the anterior wall of this canal, to a greater or less extent, during parturition. They may, however, occur from idiopathic abscess, or from malignant disease involving those parts.

Varieties.—Urinary vaginal fistulæ are essentially of two kinds, according as the communication is established between the urethra or the fundus of the bladder and the vagina. Hence they may be divided into *urethral* and *vesical*.

Urethro-vaginal fistulæ are, so far as my observation goes, of most common occurrence; and this is readily explained by the fact that the urethra passes along the anterior aspect of the vagina for some distance before it terminates in the bladder, and occupies that portion of the vaginal wall which is most likely to be compressed, during labor, under the arch of the pubes. The fistulæ are usually of small size and linear. *Vesico-vaginal fistulæ* establish a communication between the neck or fundus of the bladder and the vagina. They are consequently situated further back than the other, and are usually larger and more ragged.

Results.—The existence of a urinary fistula in the vagina is always a source of serious discomfort and distress to the patient. The dribbling of urine through the preternatural aperture is generally continuous; although, if this be situated far back behind the orifices of the ureters, it may be somewhat intermittent, a flow taking place as the lower portion of the bladder fills. The incontinence of urine thus produced gives rise to irritation and excoriation about the external parts, and occasions a strong ammoniacal odor to hang about the patient.

The precise seat and extent of the fistulous opening are best ascertained by placing the patient on her knees opposite a good light, and holding aside the posterior and lateral walls of the vagina with bent spatulæ; when the anterior aspect of that canal will have a tendency to protrude, and thus to expose the fistula, at the same time that the introduction of a bent probe, or of a female catheter, into the urethra, will guide the surgeon to the artificial opening in the urinary passage.

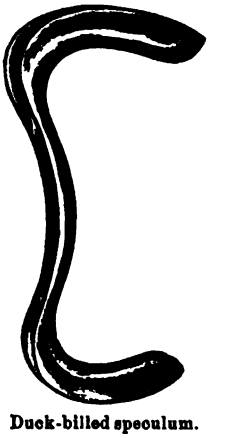
Treatment.—The cure of a vaginal fistula can only be accomplished by causing a coalescence of its sides. When it is small, about a line or two in diameter, and more especially if urethral, this may be best effected by touching the edges of the

aperture with the electric cautery or a red-hot wire, and repeating this application once a fortnight or three weeks, until a cure is effected by their gradual contraction. This little operation is most conveniently effected by placing the patient in a kneeling posture, and then holding aside the posterior and lateral vaginal walls by means of curved copper spatulæ, when the opening will be fairly brought into view.

When the fistula is larger, and especially when vesical, its cure can only be accomplished by paring the edges, and bringing them together with sutures, and thus attempting to procure union by the first intention. In effecting this, however, two difficulties present themselves—the sutures either cutting their way out too soon, or the trickling of urine between the freshly pared edges interfering with adhesion. In order to overcome these difficulties, a variety of ingenious contrivances have been introduced by different surgeons; amongst which may be especially mentioned the clamps of Marion Sims and Baker Brown, and the button-suture of Bozeman. To Sims especially is due the great merit of having substituted silver wires for silk sutures in this operation, by which the probabilities of a successful result have been very greatly increased.

Before the operation, the bowels should have been freely opened by castor-oil and an enema. No chloroform should be given, as its administration interferes with the position that the patient must maintain during the operation. [The experience of Dr. D. H. Agnew and other American surgeons has proved that anæsthetics can be as safely used in this as in any other operation. The patient can be supported with pillows in the required posture without any difficulty, and there is no occasion whatever for the great sacrifice of modesty which submitting to the operation without anæsthetics would entail.—A.] This should be on the knees and elbows, on a narrow table, with the buttocks well raised and the head low. It is of great moment that the parts should be freely exposed. This is best done by means of the "duck-billed" speculum (Fig. 596), by which the posterior wall of the vagina is well drawn up and out of the way of the operator, and light is reflected on the fistulous opening. The edges of the aperture are now to be freely pared. This is best done by seizing them with a hook-forceps or a double hook, and dissecting off the vaginal mucous membrane to the extent of about a quarter of an inch all round, by means of a fine small scalpel or angularly set knives (Figs. 597, 598) and scissors properly curved. The dissection should be carried towards the fissure, and especial care taken that the angles are well cleared of mucous membrane.

Fig. 596.



Duck-billed speculum.

After the edges of the fistula have been freely pared, and all bridles or cicatricial constrictions divided, sutures of silver or annealed iron wire (which does not rust) are

Fig. 597.

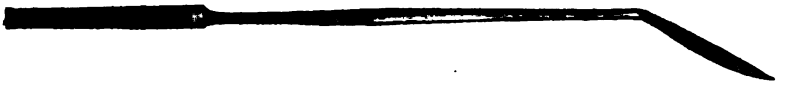
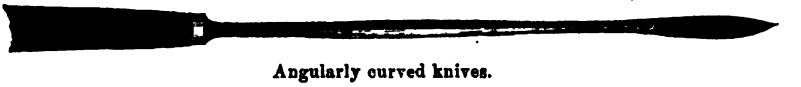


Fig. 598.

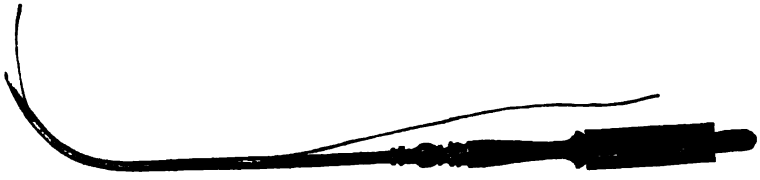


Angularly curved knives.

passed across the lips of the wound. These wires may most conveniently be passed by means of the hollow needle (Fig. 599); or, if this be not at hand, a silk thread may be passed by a nævus or cork-screw needle, a full half inch from the freshened edge of the fistula, and brought out through a corresponding point on the other side of the fistula, without having transfixed the mucous membrane of the bladder. As many threads as necessary having been passed in this way, a piece of silver wire about eighteen inches long is attached to the silk, which is then drawn out, leaving the wire to occupy its place, so that its centre corresponds to the fissure, and both ends hang out of the vagina. Sims then passes the uppermost free ends through

holes made in a narrow leaden bar, on which they are clamped, by having split shot fixed upon them in the same way as is done on a fishing line. The unclamped wires

Fig. 599.



Hollow suture needle.

are now drawn down until the bar is pulled close to the upper suture holes; and a second clamp is then fixed to these ends and is pushed up against the lower suture apertures. In this way the edges of the fistula are brought and held together on each side by a clamp, which may be allowed to remain in from seven to ten days. The clamps may then be removed by clipping off the flattened shots from the anterior one, which is thus detached from its bed. The posterior one, with the wires attached, may then be hooked up, pushed backwards, and lifted out of the vagina with forceps. Instead of a clamp Simpson uses a splint made of annealed iron wire, which surrounds and supports the tissues around the fistula. In many cases, however, where the fistula is of but moderate size, the clamp and splint may be dispensed with, and the edges of the opening brought together with the suture wires only.

In the after-treatment, especial attention is required: and here the great point is to prevent the contact of the urine with the edges of the fistula. With this view a catheter should be introduced, and worn in the bladder, so that no urine may collect in this organ. For this purpose, Sims has invented a very ingenious catheter, represented in the annexed cut (Fig. 600), which may be worn with more comfort, and with less chance of slipping than the ordinary instrument. After the patient has been put to bed, and the catheter introduced, a full opiate should be given, and continued throughout the treatment, with a view of preventing the action of the bowels, a point on which Sims lays much stress, and to which the success of his operations may be in a great measure attributed. It is very seldom that they require to be opened for ten or fifteen days, provided the patient be kept on a rigid diet. During this treatment the catheter may be removed once or twice a day, in order to be cleansed and to be kept free from phosphatic or mucous accumulations; and free ablutions of the external genitals by sponge or syringe and warm water should be practised during the whole of the treatment. After the removal of the sutures, Sims advises that the catheter should be continued, and great care taken that the patient do not move too soon, lest the weak cicatrix be strained.

Fig. 600.

Sims's catheter.

A very simple and successful mode of closing these fistulæ has been invented by Bozeman, by what he terms the "button-suture." After paring the edges of the fistula, and passing silver wires across in the usual way, he draws the parts together by passing both ends of the wire through an aperture in a steel rod, which being carried along them closes the opening. A thin leaden plate, "the button," pro-

Fig. 601.

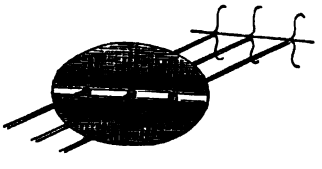
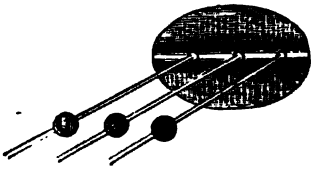


Fig. 602.



Bozeman's apparatus for button suture.

perly perforated down the middle, is then slipped along the wires so as to cover the fistula (Fig. 601); and split shot having been pushed along, their free extremi-

the leaden plate carefully lifted off, and the suture wires, having been straightened out, are withdrawn.

Whatever kind of suture may be employed, it is always of great importance that the edges of the fistula be brought together *transversely* to the long axis of the vagina. Should the abnormal aperture be close to, or even implicate, the cervix uteri, this part may be drawn and transfixed with the sutures, thus adding materially to the support of the posterior lip of the fissure.

TUMORS OF THE URETHRA.

Small *polypoid tumors* are not unfrequently met with inside the urethral orifice. They have occasionally a gonorrhœal origin, though they commonly arise irrespectively of such disease. They are always very vascular, and are most frequently met with in or around the female urethra, where they are of a bright red color, have a florid hue, bleed freely when touched, and are composed of a spongy kind of erectile tissue; they are commonly conoidal or oval, encircling the urethral orifice on one side, or even forming a complete zone around it. They grow slowly, and seldom attain a larger size than that of a raspberry. They are not unfrequently accompanied by a vast deal of sympathetic irritation, great pain in micturition, attended by an admixture of mucus or pus in the urine, uneasiness of the lower part of the abdomen, and often aching in the loins.

These vascular tumors are far less frequent in the male than in the female urethra. When they occur in men, they usually constitute a small granular florid mass inside the orifice of the canal.

When seated in or around the female urethra, these tumors not unfrequently give rise to very great and continuous irritation; much pain during and after passing urine, radiating through the whole pelvic region, and, in fact, many of the symptoms of stone; so that patients laboring under this affection are often sounded on the supposition of the existence of calculus.

Treatment.—Vascular urethral tumors may be removed in four ways:—by excision, ligature, caustics, or the actual cautery.

1. *Excision.*—When situated within the male urethra, the tumors should be snipped off by a fine pair of curved scissors. When situated in or around the female urethra, if of small size and pedunculated, they may readily enough be removed by the scissors or dissected away; the canal of the urethra being encroached on as little as possible. This operation is, however, always attended or followed by very considerable and continuous arterial hemorrhage, which has even, in some instances, been fatal. Hence, when the tumor is large and the patient weakly, excision should be practised with much caution. If it be done, the hemorrhage may be arrested by the introduction of a catheter into the urethra, and by firm pressure on the bleeding surface by means of a pad of lint, supported by a T-bandage.

2. *Ligature* is not a convenient mode of removing these growths; its application is difficult, very painful, and tedious.

3. *Caustics*, particularly strong nitric acid or potassa cum calce, may be very conveniently employed where the tumor is of small size and very vascular. In applying them, the upper wall of the canal must be protected by a broad director introduced along it.

4. The *actual cautery* is the most convenient agent for the removal of vascular tumors from the *female* urethra. By it they are at once destroyed without hemorrhage; and the eschar that is formed protects the subjacent raw surface from the irritation of the urine. If they be situated deeply within the urethra, and of small size, the galvanic cautery or a red-hot wire will most easily reach them; but if they be at or around the orifice, I employ a small olive-shaped cautery. During its application, the surrounding parts must be protected from the action of heat by a wooden spoon having a hole cut in the middle through which the application is made, and the upper wall of the urethra by a director or silver catheter, which should be retained after the operation.

CHAPTER LXXI.

DISEASES OF THE PENIS AND SCROTUM.

DISEASES OF THE PENIS.

Congenital Malformations.—I have once, and once only, met with a very curious malformation of the genital organs, the penis being tied down by its under surface to the scrotum, so as to lie in a deep sulcus between the testes. In this case the raphe of the scrotum appeared to be continued in a narrow rather firm band upwards to the under surface of the penis, so that this organ was always bent or bowed downwards. The patient passed his urine downwards, apparently from the under surface of the scrotum; when erection took place, the penis curved up in a semicircular form, the convexity upwards, the glans penis being tightly tied down to the scrotum by the narrow dense band continued up from the raphe. In fact, the condition of this organ was very like that which is met with in the tongue when "tongue-tied."

Hypospadias.—It occasionally happens that there is an arrest of union in the mesial line of the penis, so that a slit or fissure is left communicating with the urethra. This gap commonly occurs on the under surface of the organ, constituting *hypospadias*, and is confined to the glans and upper part of the penis; though it occasionally extends backwards to the root of the organ, and may then be associated with some of those kinds of malformation that are erroneously considered as examples of hermaphroditism. These conditions are mostly incurable, though plastic proceedings have occasionally been devised for their relief.

Epispadias.—The upper surface of the penis is less frequently fissured; only, I believe, in cases of extroversion of the bladder. This condition, termed *epispadias*, may be looked upon as incurable.

Phimosis.—The prepuce is not unfrequently the seat of malformation or disease. That condition of it in which it is so much elongated that it extends beyond the glans, and at the same time is so much contracted that it prevents the proper exposure of this portion of the organ, is termed *phimosis*. This may be either congenital, or acquired as the result of inflammation or disease.

Fig. 603.

Congenital phimosis.

In *congenital phimosis*, the penis is usually somewhat atrophied, and the development of the glans is prevented by the pressure of the narrow prepuce. In congenital phimosis the skin is usually abundant and lax; but the mucous lining of the prepuce is short, contracted and undeveloped. It is in this situation, and not in the skin, that the congenital defect is situated. In the majority of cases this condition is simply a source of inconvenience; but it may become a cause of disease from the retention of the sebaceous secretion of the part setting up irritation and repeated attacks of inflammation (Fig. 603). In the opinion of some surgeons, congenital phimosis is a predisposing cause of cancer of the penis. In some cases the preputial orifice is so tight as to interfere materially with the discharge of the urine, which passes from the urethra into a kind of pouch between the glans and prepuce, distends this structure, and is then squeezed in a fine jet, or in a scattered sprinkling stream through the narrowed preputial orifice, as a consequence of this impediment; and irritability of the bladder, often presenting symptoms simulating calculus, may thus be set up. At a more advanced period of life I have known it a cause of impotence, or rather interfering with conception in the wife, by semen after emission being retained under the tight and narrow prepuce until erection had completely subsided. Congenital phimosis especially becomes a source of inconvenience in after-life if any gonorrhœal or venereal disease be contracted, as it renders the exposure of the diseased part difficult or impossible, and interferes with the necessary treatment.

In old men, phimosis will sometimes occur as a consequence of the irritation set up by cracks, fissures, or superficial ulcerations forming round the preputial orifice, which becomes thickened and narrow, with œdema of the subcutaneous areolar tissue, so as to prevent the glans from being uncovered.

Treatment.—Phimosis, when not congenital, must be treated in accordance with its cause: thus, if it have resulted from inflammation, that must be subdued; if from venereal disease, that must be remedied, when perhaps the contraction and elongation will gradually subside. If, however, the phimosis be congenital, or if, though acquired, it be permanent, it should be subjected to operation; and, indeed, I think that all cases of congenital phimosis in children should be operated upon, with the view of preserving the health and cleanliness of the parts in after life.

In the acquired phimosis of old men, consequent upon contraction following cracks of the preputial margin, I have found that dilatation may safely and speedily be effected by the introduction of a two-bladed urethral dilator (Fig. 586), which, being gradually screwed open, causes the indurated circle to yield.

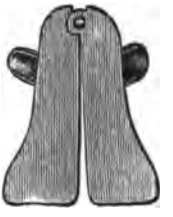
Operations for phimosis may be conducted on two plans; the elongated and contracted prepuce may be slit up, or circumcision may be performed.

Slitting up of the prepuce, whether upon its upper or under surface, is, I think, an objectionable procedure, leaving the prepuce of its abnormal length, and more or less fissured and knobbed. In all cases I prefer circumcision as the simplest and speediest operation, and as leaving the most satisfactory result.

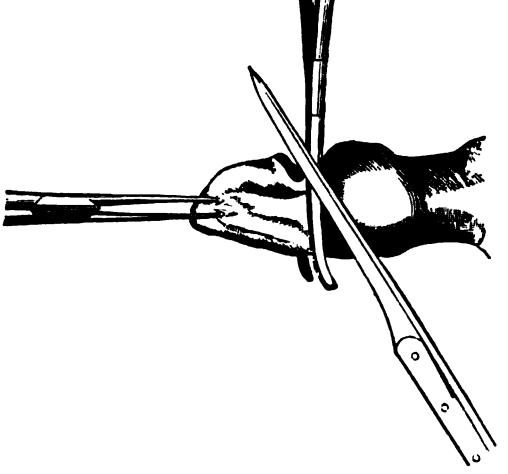
Circumcision for congenital phimosis in infants and young children is most easily and safely performed according to the Hebrew rite, which I have several times had an opportunity of witnessing, and which is done as follows. The child being held on the lap of an assistant, the operator draws the foreskin slightly forwards, and then grasps it just in front of the glans by drawing it through a slit in a silver guard. This is not held perpendicularly downwards, but is inclined from above slightly forwards and downwards, so as to avoid cutting the frænum as much as possible, and to slice off the prepuce in an oblique or quilled manner. This is done by one stroke of a broad round-ended knife. The mucous membrane is then torn open between the finger and thumb along the dorsum of the penis, and is turned back so as to be brought into contact with the cut edge of the skin. A strip of dry lint is then twisted round the organ in the sulcus behind the glans, so as to keep back the mucous membrane, and also to restrain hemorrhage by its pressure. Union is perfect in a few days. This operation, which is practised on the eighth day after birth, is very rarely attended by any ill consequences. I have, however, seen it in one case followed by fatal erysipelas, and have heard of another instance in which death occurred from hemorrhage.

Circumcision in the adult for disease of the prepuce may most conveniently be performed in the following way. The surgeon, having tied a tape tightly round the root of the penis to restrain hemorrhage during the operation, draws the elongated prepuce slightly forwards, until that portion of it which corresponds to the back of the glans is brought just in front of that structure. He then seizes the projecting prepuce immediately in front of the glans with a pair of narrow-bladed polypus forceps, which he gives to an assistant, who must hold them tightly, or he grasps it and protects the glans by means of a plate (Fig. 604), which I have had constructed for this purpose. With one sweep of the bistoury he cuts off all that portion of the integument which projects beyond the forceps, which are then taken away (Fig. 605). It will now be found that he has only removed a circle of skin, but that the mucous membrane lining it still tightly embraces the glans; this he slits up, by introducing the point of a pair of scissors at the preputial orifice; and then, trimming off the angles of the flaps of mucous membrane, and snipping across the frænum, he turns back the mucous membrane, and attaches it to the edge of the cutaneous incision by five points of metallic suture, two on each side and one at the frænum. Before introducing these, he will generally find it necessary to ligature a small artery on each side of the penis, and one or two in the frænum.

Fig. 604.



Instrument for holding the prepuce in circumcision.



Circumcision in the adult.

cicatrix is left, by which the patient is by no means inconvenienced. In some cases I have found adhesions

Fig. 606.

Sloughing of the prepuce and protrusion of the glans.

between the prepuce and the glans; these require to be dissected through, but no inconvenience results from this slight addition to the operation.

If sloughing of the prepuce have occurred, allowing the glans to protrude, as in Fig. 606, circumcision must be practised.

[The neatest operation for phimosis is that done with the fenestrated forceps of Ricord. They should be applied obliquely so as not to involve the frænum, and well back, as otherwise a sufficient portion of the prepuce may not be removed. I have seen troublesome secondary hemorrhage in one case where the frænum was divided at too high a point.—A.]

Paraphimosis.—In *paraphimosis* the prepuce has been forcibly drawn back behind the glans, which becomes strangled by the pressure exercised by the preputial orifice, so that the parts cannot be replaced in proper relation to one another. This accident principally occurs in boys, or in individuals who have naturally a tight prepuce, and who, on uncovering the glans, find it difficult to get this part of the organ back. This difficulty is speedily and greatly increased by the swelling from congestion that is set up in the constricted glans.

Treatment.—This is sufficiently simple. The surgeon should first try to reduce the swollen organ. He may often succeed in doing this by seizing the body of the penis between the index and middle fingers of each hand, and then endeavoring to draw the prepuce forwards, at the same time that he compresses the glands between

Fig. 607.

Reduction of paraphimosis.

Fig. 608.

Incision in operation for paraphimosis.

the two thumbs and pushes it back (Fig. 607). Should reduction not be effected in this way, the constricted and strangulating preputial orifice must be divided. In

the other by a fold of integument, corresponds to the inner margin of the preputial orifice; and it is by the division of this, in which the stricture is situated, that immediate relief will be given. This operation may readily be done by drawing the glans forwards, then passing the point of a narrow-bladed scalpel into the sulcus on the dorsum of the penis, and making a perpendicular incision about one-third of an inch in length through the integuments at the bottom of the groove directly across it (Fig. 608). In consequence of the great stretching of the parts, the incision will immediately gape widely; so that, instead of being longitudinal, it will appear to be transverse; and then reduction of the glans may readily be effected.

Balanitis.—Inflammation of the prepuce commonly occurs as the result of local irritation, not unfrequently set up by a gonorrhœa. When confined to the prepuce, and constituting *balanitis*, that structure is much swollen, infiltrated, and reddened, and, while the inflammation lasts, continues in a state of phimosis. When the mucous membrane of the glans is affected as well, constituting *posthitis*, there is a good deal of irritation and smarting, together with muco-purulent discharge.

Treatment.—The disease requires to be treated on ordinary antiphlogistic principles. The continued application of lead lotion, with the internal administration of salines, will generally remove it; but in many instances the most effectual plan will be found to consist in rapidly sweeping the inflamed surfaces with a stick of nitrate of silver passed down between them on one side of the frænum, and carried round to the opposite side.

[Balano-posthitis may be conveniently treated by packing the preputial fold with lint saturated with a solution of nitrate of silver (℈j–f℥j).—A.]

Herpes of the Glans and Prepuce is characterized by the formation of small vesicles or excoriated points upon the mucous membrane of this region, attended by much smarting and itching, and chiefly occurring in persons of a gouty habit of body, with an irritable mucous membrane.

Treatment.—This slight affection is often very rebellious to treatment. In many instances, local means alone will not suffice; for, though relief may be obtained by powdering the part with the oxide of zinc, or by using slightly astringent and cooling lotions, yet no permanent benefit will be derived unless constitutional irritation be removed by treatment of a cooling or alterative character, modified according to the circumstances of the case.

Hypertrophy of the Prepuce not unfrequently occurs as the result of chronic irritation or disease; it is usually of limited extent, and requires no special interference on the part of the surgeon; but in some instances it may become so extensive as to require operative interference. The disease then usually consists of a solid œdema of the areolar tissue of the prepuce and of the subintegumental structures of the body of the penis, the organ being very greatly enlarged and becoming club-shaped. In these cases circumcision of the hypertrophied prepuce, with the excision of a V-shaped piece from the dorsum of the penis, will usually be found to leave a good and satisfactory result. But a greater magnitude than this may be attained. Thus Vidal has related and figured a case that had attained such an enormous size, that the organ reached to below the knees, and was as large as a thigh. This monstrous growth was successfully excised.

Fig. 609.

Warts on the penis.

Warts on the penis have already been described. They may attain a very large size, as in Fig. 609, and are best treated by being snipped off with curved scissors.

Cancer of the Penis is of two distinct kinds, occurring as scirrhus or as epithelioma. When cancer assumes the *scirrhous* form, it usually springs from the sulcus behind the glans, and may thence invade the neighboring portion of the organ. It may assume the primary form either of a tubercle or of infiltrated cancer of the glans. It has been supposed, and with some show of reason, that congenital phimosis predisposes to the affection; probably by

confining the secretions, and thus keeping up irritation of the part. Hey found that, of 12 patients with this disease who came under his observation, 9 had congenital phimosis; and Travers states that Jews, who are circumcised, are seldom subject to this affection. But as they are a limited community in this country, and as the disease is rare, we cannot draw any conclusive inference from this observation. It is, I think, very probable that the epithelial form of the disease may arise from the local irritation resulting from congenital phimosis. The scirrhous form of the affection, however, can occur in individuals who have not suffered from phimosis; of this we have had several instances at the University College Hospital.

Epithelioma, commencing as a tubercle in the prepuce, may, after a time, give rise to a large irregular and sprouting mass, having a granular fungous appearance, bleeding with much fetid discharge, growing rapidly, enveloping and at last implicating the glans (Fig. 610). In other cases it commences as a hard scirrhous mass of a pale reddish-white color, situated on the glans, or between the prepuce and the glans. This increases in size, at last cracks, and allows a serous fetid discharge to exude. Ulceration then rapidly takes place. Sometimes the disease appears to be very distinctly localized; but after its removal it will always present the character of infiltrated cancer. It is, I believe, always primarily situated at the anterior extremity of the penis, not occurring in the body of the organ except as a secondary deposit.

Fig. 610.

Epithelioma of the penis.

Diagnosis.—Epithelioma of the penis requires to be diagnosed from *fungoid warts*. This may usually be done readily enough, by comparing the indurated state of the malignant with the soft and lax condition of the non-malignant affection. From *chancrous induration* of the glans, the history of the case and the way in which it is influenced by treatment will enable the surgeon to effect the diagnosis of scirrhus. In indurated plastic effusions into the corpus spongiosum no pain is experienced, and the disease remains in a stationary condition.

Treatment.—The treatment of cancer of the penis will vary according to the nature and extent of the malignant affection.

In the *epithelial* form of the disease the surgeon may, if he see the case early, whilst the morbid growth is small and limited to the prepuce, content himself with dissecting off the affected patch. Should the epithelioma, however, have attained a large size (Fig. 610), and more particularly if it have implicated the glans, then amputation of the organ is indicated.

The treatment of *scirrhus* of the penis must be conducted on the principles that guide us in the management of malignant affections wherever situated; viz., to remove the diseased organ at as early a stage as possible, whilst the affection is localized, before the glands are implicated and the constitution poisoned. In the penis, this may readily be done by an operation that is simple in its execution and devoid of danger. In many cases, more especially of scirrhus, a return may take place, and that speedily either in the part itself or in the neighboring lymphatic glands; yet, even if this occur, it is clearly the duty of the surgeon to rid the patient of a loathsome disease, and to put him in a state of comparative comfort for some months; the more so, as there can be no doubt that, in some instances, the disease may be entirely extirpated from the system, evincing no tendency to return. Indeed, I believe that amputation of the penis for cancer is more successful in its results than the extirpation of malignant growths from most other situations. In the epithelial form of the disease it is especially a useful operation. In some of Hey's cases, which continued under his observation, there was no recurrence of the disease for several years. I have seen several patients who, after a lapse of six or eight years, continue free from a recurrence of the disease; and I have also seen a gentleman who had his penis amputated for cancer more than twenty years ago, and in whom no return has taken place. The fact is, that we see and hear of those cases in which a recurrence takes place; but those patients who remain free from a return of the affection do not divulge their infirmity; and it is exceedingly rare in hospital practice to find a patient come back with recurrent cancer in the stump of the penis, which he would certainly do if relapse took place. In those cases in which the operation is not successful, it has usually been delayed too long, the disease having

Amputation of the penis may be practised either with the knife or with the ecraseur. Whichever instrument is used, the operation should always be performed towards the root of the organ, so as to be well clear of the disease; at the same time, care must be taken not to remove the organ too near the pubis, lest the stump retract under that bone. The operation with the knife may readily be done by the surgeon putting the penis upon the stretch, drawing the integument well *forward*, and then severing the organ at one stroke of the bistoury. As the corpora cavernosa retract more than the integument, it is well not to leave too much skin; lest the flap, falling over the face of the stump, make the search for any bleeding vessels somewhat difficult, and afterwards pucker inconveniently. The hemorrhage during the operation may be effectually restrained by tying a narrow tape tightly round the root of the penis. There are usually five arteries requiring ligature: the dorsales penis, one in each corpus cavernosum, and one in the septum. In securing these, trouble is not unfrequently experienced in consequence of the retraction of the stump that is left. The liability to this, however, is lessened by tying a tape round the root of the organ before the operation is commenced, or by directing the assistant to hold it firmly between the fingers, and thus to prevent the retraction of the stump, which may otherwise draw back and be buried under the pubic arch, almost in the perineum. Should it do so, and oozing continue, a female catheter must be passed into the urethra, and a firm compress applied with a T-bandage. During and after cicatrization, the urethral orifice has a tendency to contract. The liability of this may, however, be lessened by drawing forwards the mucous membrane, making four cuts in it with a pair of scissors, and then stitching it to the edge of the cut skin. If the amputation be performed high up, this may be somewhat difficult; and then it may be safer to introduce an elastic catheter before the operation, to perform the amputation upon and through this, and to leave it in during cicatrization. When the écraseur is used, the skin should similarly be drawn forwards, and the instrument worked slowly, so as to divide the organ without inducing hemorrhage.

After amputation of the penis, the urine will not be projected forwards, but always passes directly downwards between the legs. Any inconvenience in this respect may best be avoided by following Ambrose Paré's advice of adapting a funnel, which may be made of metal or ivory, to the pubes over the stump, and thus carrying the urine clear of the person.

Other tumors besides cancers are occasionally met with in the penis. I have seen *encysted tumors* and *nævus* situated under the prepuce (page 577), and *fibro-plastic tumor* of this structure may also occur. Such morbid growths readily admit of removal without injury to the rest of the organ.

DISEASES OF THE SCROTUM.

Inflammatory Œdema of the scrotum is an erysipelatous inflammation of this region, and derives its chief peculiarity from the circumstance of its giving rise to great effusion into and swelling of the areolar tissue of this part of the penis, with a tendency to the rapid formation of slough in it, by which the integument may likewise become affected to such an extent that the testes and cords speedily become denuded. This disease usually originates from some local source of irritation, as fissures, cracks, or urinary extravasation (page 453). There is a peculiar and specific form of "inflammatory œdema" of the scrotum and penis, which is apt to occur as a sequence of smallpox and scarlet fever. In this form of the disease rapid and extensive infiltration of the parts occurs, with a tendency to speedy gangrenous disorganization of the areolar tissue and skin covering the organs of generation.

Treatment.—This consists in elevating the scrotum, fomenting it well, and making early and free incisions into it, particularly at the posterior and dependent parts of the scrotum and penis, with the view of relieving the tension to which the tissue is subjected by the effusion into its cells, and thus preventing the liability to slough. Should this occur, the case must be treated on ordinary principles, when cicatrization will speedily ensue, however extensive the denudation of parts may be. The constitutional management must always be conducted in accordance with those

Hypertrophy of the scrotum seldom occurs in this country, though Liston once had occasion to remove such a mass, weighing 44 pounds; but in some tropical regions, particularly India and China, it is of frequent occurrence, and may go on until it attain an enormous bulk, forming a tumor nearly as large as the trunk, and perhaps weighing 60 or 70 pounds. These enormous growths are of simple character, and constitute the disease termed *elephantiasis of the scrotum*. Fig. 611 represents a tumor of this kind, weighing 40 pounds, which was successfully removed by Rogers, of the Mauritius. It is taken from a photograph of the case, kindly sent to me by that gentleman.

Fig. 611.

Elephantiasis of the scrotum.

Treatment.—Tumors of this kind necessarily require extirpation. In performing such operations there are two points that demand special attention: the first is to preserve the penis and testes if possible, which will usually be found buried towards the upper part of the mass, and may be saved if the tumor be of small size; and the second is, to endeavor to prevent the hemorrhage from being too profuse. With this view, the operation ought not only to be performed as rapidly as possible, but the suggestion made by O'Ferrall of elevating the tumor above the level of the body, for some time before its removal, so as to empty it of its blood, may be advantageously adopted. If the growth be very large, it will be better not to make any attempt at saving the testes or penis, which could only be dissected out by a long and tedious operation, in the course of which there would be danger of the patient dying of hemorrhage.

Cancerous or Cancroid Disease occasionally affects the scrotum; and, as it principally occurs in chimney-sweepers, it has been appropriately termed *chimney-sweeper's cancer*. This affection appears to arise from the irritation of the soot lodging in the folds of the scrotum. It commonly commences as a tubercle or wart, which after a time cracks or ulcerates, presenting the ordinary characters of a cancerous ulceration. It rapidly spreads, involving at last the greater part of the scrotum, and perhaps invading the testis. After a time, the inguinal and pelvic glands will be affected; and the patient, if deprived of his covering of soot, will be found to be cachectic-looking.

The *treatment* consists in excising widely the diseased portion of the scrotum, provided the inguinal glands be not involved, or the patient's constitution poisoned. The disease has a great tendency to return, and it is seldom that the patient long escapes with life when once he has been affected by it.

CHAPTER LXXII.

DISEASES OF THE TESTIS AND CORD.

MALPOSITION OF THE TESTIS.

The testes are, in the fœtus, contained within the abdomen, and in the normal condition descend into the scrotum a short time before birth. From some arrest of development this descent may be retarded on one or both sides; and in other instances it never takes place. An undescended testis may continue to lie within the cavity of the abdomen; or it may find its way into the internal ring; or may

undescended, as has been stated at page 978, become complicated with a hernia, and may present many diagnostic difficulties. Inflammation of the testis retained in the canal will be considered at page 1149. When an undescended testis becomes the seat of structural degeneration, it may require removal from the canal. The testis may be met with in other abnormal situations; thus, some time ago I saw a case in which one of these organs was situated in the perineum, close by the anus, having apparently missed the scrotum; and cases have occurred in which they have been met with in the interior of the pelvis. The organ may sometimes be turned hindside forwards, being retroverted, so that the epididymis is placed in front. In a case of this kind which I had an opportunity of examining after death a few years ago, the epididymis and vas deferens were considerably larger than natural. If a hydrocele form in such a case, it will be seated behind the testis.

There is a very important question connected with malposition of the testis, viz.: Is the organ when undescended prolific? There is reason to believe that it is not. Such testes are small, hard, and granular in structure; and, when they are examined under the microscope, spermatozoa are not found in them. When only one testis is undescended, the other one, being in its proper position, carries on the functions of the two organs; but when both testes are retained in the canal or in the abdomen, being undescended, the individual who is the subject of such malposition will most probably be sterile. He may have the usual erotic feelings, full power of erection, and of emission of a spermatic fluid; but the secretion will have no fecundating power.

NEURALGIA OF THE TESTIS.

A painful or irritable condition of the testicle may occur without any actual disease of the organ; the pain being either seated in the epididymis, which is the part naturally the most tender, in the body of the testis, or stretching along the cord to the loins and groins. It is usually paroxysmal, and is accompanied by great tenderness, and commonly by some fulness of the organ, which feels soft and flaccid; but it is difficult to make a proper examination, on account of the agony that is induced by touching the part. This disease chiefly occurs in young men of a nervous and excitable temperament, and is frequently associated with great mental disquietude and despondency, often amounting to a suicidal tendency.

The *causes* are obscure; in many cases the disease appears to be connected with a neuralgic temperament, but in others it is associated with some dyspeptic disorder, or may be dependent upon local irritation; thus external piles, or the pressure of a varicocele, will often give rise to it.

The disease is usually of a very chronic character. In some instances, however, it ceases spontaneously, after having lasted for weeks or months.

Treatment.—When the neuralgia is dependent upon constitutional causes, the treatment is extremely unsatisfactory. The administration of tonics, such as iron, zinc, or quinine, the local application of sedatives, as of atropine ointment, or the tincture of aconite, may be of service. In other cases, cold bathing or douching will be beneficial; and, in all, keeping the part supported with a suspensory bandage will be advantageous. In the event of there being any local irritation, that should be removed; thus I have known the disease to cease after the excision of external piles; and when it is connected with varicocele, proper measures must be adopted for the relief of that affection.

[*Galvanism* has occasionally been found very useful in the treatment of neuralgia of the testis.—A.]

In extreme cases, Sir A. Cooper recommends castration; but such a proceeding is altogether unjustifiable in a disease that is either constitutional, or dependent on local causes which are readily removable.

INFLAMMATION OF THE TESTIS.

Inflammation of the testicle, considering the organ as a whole, may be of two distinct kinds, varying as to seat and as to cause. Thus it may be seated in the body

Acute Inflammation.—The *seat* of the inflammation, at the commencement of the disease, depends greatly upon the cause, which may be in the urinary passages or elsewhere. Irritation in any part of the urethra, occasioned by the passage of instruments, by the lodgment of calculi, or by gonorrhœal inflammation, usually causes the epididymis to be primarily affected, and the body of the organ to be inflamed in a secondary manner. When, on the other hand, the inflammation comes on from injuries, blows, strains, or other causes acting generally, the body of the testis is usually first affected. To all this, however, exceptions will often occur; and orchitis may supervene as the result of gonorrhœa, or epididymitis from a blow. The orchitis in such cases is in all probability a kind of constitutional affection, intimately associated with inflammation of other fibrous tissues, especially with gonorrhœal rheumatism; the inflammation of the epididymis, arising from gonorrhœa or other irritation of the urinary passages, appearing to result from direct extension of morbid action along the vas deferens.

Symptoms.—These necessarily vary to a certain extent, not only according as the disease is of an acute or of a chronic character, but as it primarily affects the body of the testis or the epididymis. When it commences in the latter structure, it is the inferior globus that is commonly first affected, which becomes swollen, hard, and tender. The disease may be confined throughout to this part; but most frequently it invades the whole of the organ, which becomes uniformly enlarged and somewhat ovoid; it is frequently accompanied by a good deal of effusion into the tunica vaginalis, then constituting the *acute hydrocele* of Velpeau. As the inflammation subsides, the different characters presented by the enlargement of the two constituents of the organ again become apparent. The swelling is therefore due partly to general enlargement of the organ, but in some cases to inflammatory effusion into the tunica vaginalis; and this may either be of a purely serous, or partly of a plastic character.

The pain is always very severe, with much tenderness and a sensation of weight, and commonly extends up the cord into the groin and loin. It is generally greatest when the body of the testis is affected, owing probably to the enveloping fibrous tunic preventing the expansion of the organ. Hence it is often very spasmodic and paroxysmal, extending up the course of the cord. There are usually considerable swelling and redness of the scrotum, with turgescence of the scrotal veins, and a congested state of the cord, with sharp pyrexia, nausea, and perhaps occasional vomiting.

As the disease subsides, the body of the testis first resumes its normal character and shape, the epididymis often continuing hardened and enlarged for a considerable period. In fact, the induration that forms in the epididymis may become somewhat permanent, owing to the effusion of plastic matter into it, leaving a hardened mass, and implicating the whole or a portion of its convolutions.

Subacute Orchitis usually comes on with the same symptoms, though in a less marked form than in the acute variety. The swelling, however, is considerable, though of a softer kind. When the disease is chronic, the testis often becomes permanently enlarged and hardened, assuming an oval shape, being smooth, heavy, and uniformly expanded, with a sensation of weight, dragging and severe pain, and a good deal of tenderness on pressure. This form of orchitis occasionally occurs in old people.

Treatment.—The treatment of *acutely inflamed testicle*, whether local or constitutional, is essentially antiphlogistic. Blood should be abstracted from the part by puncturing the veins of the scrotum—a far better method than applying leeches, the bites of which are apt to become irritated. This little operation may be very effectually done by directing the patient to stand up, and to foment the scrotum for a few minutes with a hot sponge, so as to distend the veins; these may then be punctured at various points with a fine lancet, and the parts well fomented afterwards, so as to encourage the flow of blood. In this way six or eight ounces may be taken in the course of a few minutes; when enough has escaped, the further flow may be arrested by laying the patient down and elevating the part.

The patient should be kept in bed with the testis raised on a small pillow between the thighs, poppy fomentations being diligently applied. If there be much effusion

[I am in the habit of treating the swollen testicle of gonorrhœa by incision of the tunica albuginea, as practised by Vidal (de Cassis) and H. Smith, of London. The pain is almost instantly relieved, and the duration of the disease very materially shortened.—A.]

The *constitutional treatment* during the acute stage consists in the administration of salines and antimony, with henbane in full doses, so as to give an aperient, a diaphoretic, and a sedative together; when this begins to act, great relief is usually afforded.

As the inflammation subsides, the treatment must be changed. When there is merely swelling and hardness left, with but little pain or tenderness, the testis may advantageously be strapped with adhesive plaster, so as to give good support and to promote absorption of plastic matter. Fricke of Hamburg has strongly recommended strapping in the acute stage; but I cannot say that I have ever seen any advantage derived from it at this period of the disease, though I have many times seen it tried; it has usually appeared to me to increase, sometimes very considerably, the pain in the part and the general uneasiness.

In *subacute orchitis* much benefit is usually derived from a short course of Dover's powder and calomel, with early strapping of the testis. When the organ has become enlarged and indurated, as the result of chronic inflammation, it may be advantageously strapped, either with simple plaster, or with one composed of equal parts of the emplastrum ammoniaci cum hydrargyro and soap-plaster; mercury in small doses, more especially the bichloride, being continued for some length of time, until the plastic matter is absorbed and the hardness disappears.

In *strapping a testicle*, the scrotum should be shaved, and then drawn tightly upwards on the affected side. The surgeon should next pass a long strip of plaster, about an inch broad, above the enlarged testicle and round the corresponding side of the scrotum, so as to isolate it, as it were. Another strip is now passed from behind, in a longitudinal direction, over the lower end of the testis, and upwards upon the anterior part of the scrotum; and thus, by a succession of horizontal and vertical strips, neatly overlapping and drawn tightly, the organ is completely enveloped and compressed. To be of any service, the strapping must be tightly and evenly applied; but at the same time care must be taken not to strangulate the scrotum by drawing down the upper strips of plaster too forcibly. In a case of "tuberculo-syphilitic" disease of the testis, in which I was obliged to have recourse to castration, the whole of the side of the scrotum had sloughed away, leaving the testis exposed and fungating, in consequence of the tight strapping which had been employed before the case came into my hands.

Abscess, as the result of inflammation of the testis, is of rare occurrence: sometimes, however, the scrotum inflames at one point, where fluctuation becomes apparent, with thinned skin and evident signs of suppuration; a puncture should here be made, and the pus let out as soon as formed. Sometimes abscess may occur in another way: inflammation is set up in the tunica albuginea, adhesion takes place between the testis and the scrotum, abscess forms under the fibrous coat, and, this giving way, the pus gets vent externally through the integuments. Into the aperture that necessarily results, a portion of the secreting tissue of the gland sometimes projects, and becoming inflamed, forms a red, granular, and fungous mass, protruding through and overlapping the edges of the aperture. The treatment of this condition will be considered when we come to speak of the scrofulous testicle.

Inflammation of the Testis in the Inguinal Canal may sometimes take place, even in adults, when the organ has not descended through the external ring; giving rise to a train of somewhat puzzling symptoms which closely resemble those of strangulated incomplete hernia; with which, however, it must be borne in mind that it may be associated (p. 978). On examination, a large irregular tumor, in some parts hard, in others soft, very tender to the touch, and occasioning a sickening sensation when pressed, will be found in one of the groins, in the situation of the inguinal canal. There are usually a tendency to vomiting and some constipation, with colicky pains in the abdomen. These symptoms, however, are generally not very persistent, and the constipation readily yields to the administration of purgatives. On examining the scrotum, it will be found that the testis on the affected side is absent; and, on passing the finger into the external ring, the

organ can be felt to be lodged in the canal. In consequence of the proximity of the peritoneum to the inflamed testis, this membrane occasionally becomes involved in the morbid action; and, as the result of the constriction of the tendinous and aponeurotic tissues in the situation, sloughing has occasionally occurred. Either of these conditions may lead to a fatal termination.

The *treatment* should be actively antiphlogistic. Leeches must be freely applied over the part, and blood should be taken from the arm, if the patient be young and strong; salines with antimony being at the same time administered, and fomentations diligently persevered in.

Inflammation and Abscess of the Cord.—In some cases the inflammation of the testis may extend, or the disease may, from the first, be limited, to the areolar tissue of the cord, giving rise to tumefaction, with a good deal of pain and tenderness along it, and eventually abscess, accompanied by the usual signs of suppuration. The *treatment* of such a case must be conducted on ordinary principles, early discharge for the pus being secured.

HYDROCELE AND HÆMATOCELE.

By *hydrocele* is meant an accumulation of serous fluid, formed in connection with the testis or cord. Most frequently the fluid occupies the sac of the tunica vaginalis, constituting a true dropsy of it; in other instances, it appears to be formed in distinct cysts, situated either in connection with the testis, or upon the cord. Hence hydroceles are commonly divided into those that affect the *tunica vaginalis*, and the *encysted* variety.

Hydrocele of the Tunica Vaginalis may occur as the result of acute orchitis; the inflammation of the testis causing the effusion of a quantity of limpid fluid into its serous investment (p. 1148). This, however, is not the kind of hydrocele that is commonly met with; the fluid so poured out as the result of active inflammation, usually becoming absorbed as the parts recover their normal condition. The ordinary hydrocele occurs as a chronic disease, without any signs of inflammation of the testicle, or, at most, with slight tenderness of that organ. It is most frequently met with in individuals about the middle period of life, and generally in persons of feeble power, or in those of a cachectic or gouty constitution, commonly without any evident exciting cause.

In young infants, hydrocele is not unfrequently seen, and in them it may affect two forms: either the ordinary one, similar to what occurs in adults, in whom the tunica vaginalis constitutes a closed sac filled with fluid; or a less common variety, in which the accumulation of fluid in the tunica vaginalis communicates, by the persistence of a cavity or canal in the funicular prolongation of the peritoneum investing the cord, with the general cavity of that membrane. This form of hydrocele is *congenital;* and the fluid in it occupies the same position that intestine does in a congenital hernia. It may readily be recognized by the fluid being made to flow back into the general peritoneal cavity, on raising or squeezing the tumor. But, although this may be considered to be the true congenital form of hydrocele in infants, the other variety of the disease also occurs in them when but a few days old, and very possibly even at the time of birth.

Symptoms.—The symptoms of hydrocele are tolerably evident. The disease begins with a degree of swelling and weight about the testis: the swelling may at first be soft, but after a while becomes hard and tense; or it may be so from the commencement. Whatever its original condition, the tumor soon becomes oval or pyriform in shape, being narrowed above, rounded and broad below; it is smooth and uniformly tense and hard, often having a semi-elastic feel. It reaches upwards along the cord, towards the external abdominal ring, which, however is never invaded by it, and the cord is usually distinctly to be felt above the upper margin of the tumor. Most commonly the size varies from that of a hen's egg to a small cocoa-nut; but sometimes it may attain a considerably greater magnitude than this, and will then cause much deformity of the parts, as it reaches up close to the external ring, and drags over the penis, causing that organ to be buried in it.

The most characteristic sign of hydrocele is its translucency by transmitted light. This may always be detected by the surgeon grasping the posterior part of the tumor with one hand, so as to put the integuments of the forepart on the stretch, then placing the edge of the other hand along the most prominent part of the swelling,

examination be conducted in a darkened room.

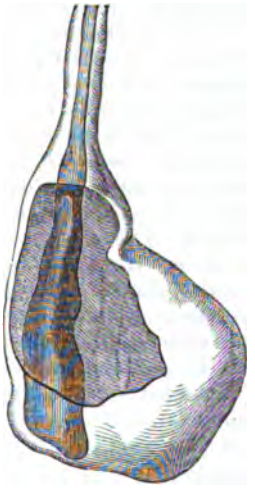
[I have seen one case of hydrocele in which there was absolutely no translucency. From this and from the firmness of the tumor, it was supposed by the surgeon in attendance to be a sarcocele. After the incision had been made for castration it was found that the tunica vaginalis had undergone calcification, a condition which fully explained the unusual symptoms.—A.]

We have already seen that the ordinary hydrocele of the tunica vaginalis may vary as to size: it may also differ as to shape; in some cases being globular, in others constricted in the middle, or of an hour-glass shape.

The quantity of liquid varies considerably; there are usually from six to twelve or twenty ounces, but I have known a hydrocele to contain more than one hundred and twenty ounces. The fluid is generally clear and limpid, and of a straw color; but in very large and old hydroceles it may become of a dark-brownish or chocolate hue, owing to the admixture of disintegrated blood; and it will then be found to contain flakes of cholesterine. The sac is usually thin; but in some old cases it becomes thick and dense, lined by a kind of false membrane, and divided by septa or bands, occasionally to such an extent as almost to separate it into distinct compartments. When the sac is thick, and the fluid opaque and turbid, there may be considerable difficulty in detecting the translucency.

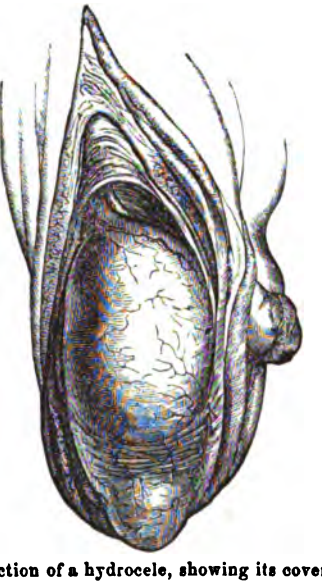
The testis is generally somewhat enlarged, especially about the epididymis, and frequently slightly tender, more particularly in the early stages of the complaint. It is almost invariably situated in the posterior part of the sac (Fig. 612), but may

Fig. 612.



Hydrocele.

Fig. 613.



Dissection of a hydrocele, showing its coverings.

sometimes be found towards its anterior part. When this is the case, the epididymis will be found turned towards the front, owing to the organ being retroverted.

The *coverings* of a hydrocele are the same as those of the testis. Besides the integumental structures, aponeurotic prolongations from the intercolumnar and cremasteric fasciæ may be traced over the surface of the swelling (Fig. 613).

Treatment.—The treatment of hydrocele is divided into the *palliative* and *curative*. By the *palliative* treatment the surgeon simply seeks to relieve the patient of the annoyance induced by the bulk or weight of the tumor; but the *curative* has for its object the permanent removal of the disease.

The *palliative treatment* consists in the use of a suspensory bandage and cooling lotion, or in tapping with a fine trocar. These simple means, however, will sometimes succeed in effecting a radical cure. Thus, in infants, it will happen that the

muriate of ammonia, ℥j of spirits of wine, and ℥viij of water; with this t
tum should be kept constantly wetted; and, if there be a communication
peritoneum, a truss should be applied over the external ring. In adu
sionally happens that simple tapping of the tumor has effected a
Some years ago, a gentleman from Cuba consulted me for a small hy
had been forming for several months; I tapped it with a fine troca
about five ounces of fluid. This was followed by a radical cure.
out a remark made by Brodie, that the few instances in which he h
tapping to produce a radical cure occurred in West Indians.
several times seen hydroceles disappear after having been t
without any other treatment, in persons who had never been in
simple operation is not altogether, however, destitute of dang
old man to die from inflammatory œdema of the scrotum aft
After tapping, it usually happens that the hydrocele slowly
its former bulk at the end of about three months. Occasio
the hydrocele returns more and more slowly after each ta
ing this simple process at intervals of three, then six
disease will finally disappear. This kind of progressiv
have several times seen, chiefly in old men. When a c
tapped, the sac soon fills again by drainage into i
indeed, in such cases the fluid of an ascites has been
vaginalis.

In tapping a hydrocele a few precautions are
avoid puncturing one of the scrotal veins, or inj
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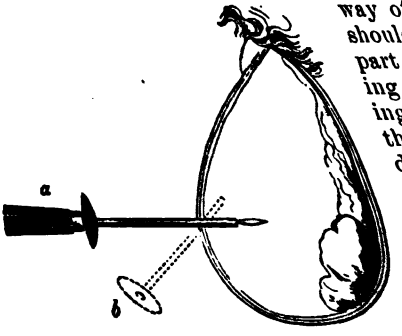
Fig. 614.



Tapping in hydrocele; *a*, introduction of trocar; *b*, position of canula.

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fluid of the hydrocele escape
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The curative treatment h
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of rapid growth. In order to prevent its attaining too large a size, it will be well to adopt palliative tapping once or twice before attempting the radical cure. Care must also be taken to remove all inflammation and tenderness about the testis, before having recourse to this means of treatment. If attention be not paid to this, recurrence of the hydrocele will probably ensue. After the proper amount of inflammation has been set up, it will be well to treat the patient as if he were suffering under an ordinary attack of orchitis, confining him to the bed or to the couch for a few days; indeed, care in the after-treatment is of very considerable importance in securing a favorable result.

The treatment by *injection* is that which is commonly employed. It consists in tapping the tumor in the usual way, and then throwing a sufficient quantity of stimulating fluid into the tunica vaginalis through the canula, so as to excite a proper amount of inflammation in it. The liquids that are employed are generally either port-wine, or a solution of the sulphate of zinc of the strength of ʒj to ʒxij, or most commonly the tincture of iodine. If the port-wine or a solution of the sulphate of zinc be employed, a sufficient quantity partly to distend the sac should be injected from an India-rubber bottle or brass syringe that can be adapted to the canula; six or eight ounces are commonly required for this purpose, and it should be allowed to remain in for some minutes before being evacuated.

Injection of iodine.—The injection of tincture of iodine, originally introduced by Sir J. R. Martin, whilst practising at Calcutta, is now commonly preferred as a more certain and a safer mode of treatment than any other. It is usually sufficient to inject about one or two drachms of the pure tincture. It should be left in for a few minutes, in proportion to the amount of pain it occasions, and then allowed to escape. [I believe the operation to be more likely to succeed if the tincture of iodine be allowed to remain in the sac as recommended by Prof. Syme. The amount used should vary from one to three fluidrachms according to the size of the hydrocele. —A.] The canula used for this purpose should be made of platinum and not of silver, which is apt to become corroded and made brittle by the action of the iodine. A good deal of inflammation will usually be set up, on the subsidence of which, the cure will be found to have been effected.

Useful as the iodine injection is, it sometimes fails in producing a radical cure of hydrocele. This is attributable to two causes: the first is, that in some cases sufficient inflammation is not set up to induce that condition of the tunica vaginalis which is necessary for a radical cure. It is well known that, when a hydrocele is radically cured by injection, it is so, not by any adhesion taking place between the two opposite surfaces of the tunica vaginalis and a consequent obliteration of its cavity, but by the inflammation that is artificially induced exciting such a modification of this membrane as to restore the balance between the secretion and absorption of the fluid by which it is naturally lubricated. Now, in some cases, sufficient inflammation is not induced by the introduction of the irritating fluid to restore the natural balance between these two functions of the membrane; and the tunica vaginalis gradually fills again after the injection, as it would after the simple operation of tapping. It occasionally happens that the patient may suffer excruciating agony at the time of the injection, from the contact of the stimulating fluid with the surface of the testis, and yet little or no inflammation may be excited. The amount of suffering, therefore, at the time of the operation is by no means proportionate to the amount of consecutive inflammation likely to be set up. Indeed, the reverse would appear to be the case in many instances: and I have often observed that, in those cases which progress most steadily to a radical cure, there is but a moderate amount of pain experienced at the time of the injection.

There is a second way in which injections would appear to fail; a considerable amount of inflammation is excited, and effusion takes place into the tunica vaginalis, which, in the course of three or four days, becomes distended to the same size, or nearly so, that it had obtained previously to the operation; but this effused fluid, instead of being absorbed by the end of the second or third week, remains unchanged in bulk, or absorption goes on to a certain point, and then seems to be arrested; the tunica vaginalis remaining distended with a certain quantity of fluid.

The proportion of cases in which the iodine injection fails to bring about a radical cure of the hydrocele is variously estimated by different surgeons. Thus Sir J. R. Martin states that in India the failures scarcely amount to 1 per cent.; Velpeau calculates them at 3 per cent. I am not aware that any statistics of this mode of

treatment in this country have been collected; but the general opinion of surgeons would appear to be decidedly in its favor, as being the most successful as well as the safest plan of treatment that has yet been introduced. In this opinion I fully coincide: yet I think it by no means improbable that the success of the iodine injection in this country might not prove to be quite so great as is generally believed. I have, during the last few years, seen a considerable number of cases of simple hydrocele of the tunica vaginalis, both in hospital and in private practice, in which a radical cure had not been effected, although recourse had been had to the iodine injection by some of the most careful and skilful surgeons of the day, as well as by myself.

One circumstance connected with the injection of tincture of iodine into the tunica vaginalis deserves note. It is that, although in some cases it occasions but little pain, in other instances the suffering induced by it is of the most severe and agonizing character—more so than follows the introduction of any other of the ordinary stimulants into the tunica vaginalis.

Seton.—The cure by the introduction of a seton, though formerly much employed, is seldom practised at the present day, chiefly on account of the danger of exciting too much inflammation. It may, however, conveniently be employed in the true hydroceles of children, and in some of those cases in which the injection fails, if practised in the manner that will immediately be described. There can be no doubt that, as a first remedy, iodine injection is preferable to the seton, in the treatment of hydrocele; but when the injection has failed, and this from no want of care on the part of the surgeon, or of attention to the after-treatment of the case, but apparently from insufficient inflammatory action having been set up in the tunica vaginalis to restore the lost balance between secretion and absorption in this membrane, the seton will, I think, be found to be the most certain means of accomplishing our object. It is true that several objections may be urged to the use of the seton: it requires much watching and care, and is occasionally apt to excite a dangerous amount of inflammation in the areolar tissue of the scrotum; and these objections are, to my mind, sufficiently valid to prevent our employing it as the ordinary treatment for the radical cure of hydrocele. But it must be remembered, that the particular cases to which I am now alluding are those in which ordinary means have proved insufficient to excite proper action, and in which, consequently, it would appear as if a greater amount of irritation could safely be borne. Indeed, nothing is more remarkable than the difference in the intensity of the inflammation that is set up in different individuals by the means that are commonly employed in the treatment of hydrocele. In some cases the most irritating injections may be thrown into the tunica vaginalis, or a seton may be drawn through the scrotum and left there for days, not only without giving rise to any injurious inflammation, but without setting up sufficient action to bring about a cure of the disease; whilst in other instances simple tapping may effect a radical cure, or may give rise to such an amount of irritation as to terminate in a fatal sloughing of the scrotum.

The seton that I employ in these cases is composed of one or two threads of dentist's silk. It may be introduced by means of a nævus-needle, the fluid of the hydrocele being allowed to drain away through the punctures thus made; or, far better, by tapping the hydrocele, and then passing a needle about six inches long, armed with the seton, up the canula, drawing it through the upper part of the scrotum, and then removing the canula, cutting off the needle, and knotting the thread loosely (Fig. 176, p. 422). [The seton may be conveniently introduced by replacing the trocar and making a second puncture, this time from within outwards. An eyed probe carrying the thread may then be passed through the canula and upon the withdrawal of the latter the seton will be in place.—A.] The thread should not be removed until the scrotum swells and becomes red, with some tenderness of the testis and effusion into the tunica vaginalis. When these effects have been produced, it may be cut and withdrawn, and the case treated in the same way as when the radical cure has been attempted by iodine injection; viz., by rest and antiphlogistic treatment. The length of time during which the seton must be left in before sufficient, or even any inflammatory action is produced, varies very considerably. In most instances, the proper amount of inflammation is excited in from twenty-four to thirty hours; but in other cases the seton may be left in for ten or twelve days, giving rise to but little inflammation, although a radical cure may result.

[In the rare contingency of both iodine injection and the seton failing of effecting

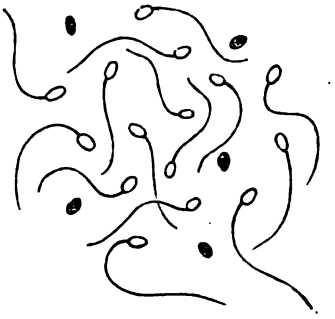
hydrocele. In persons advanced in years, or of feeble and unhealthy constitution, the inflammatory action excited in the tunica vaginalis by any of the means just detailed may run on to such an extent as to give rise to inflammatory œdema, and even sloughing of the scrotum, with great danger to life. In men advanced in years it is usually safer to temporize with the hydrocele, and only to tap as occasion arises from the increasing size of the swelling.

Encysted Hydrocele.—In this variety of the disease the fluid does not lie in the tunica vaginalis, but is contained in a cyst which projects from the surface of the epididymis or testis, and pushes the serous investment of the gland before it.

These cysts are much more frequently found connected with the epididymis, than with the body of the testicle. Indeed, Curling has pointed out the fact, that small pedunculated cysts of about the size of currants, and composed of a fine serous membrane, lined with tessellated epithelium, are very frequently found beneath the visceral tunica vaginalis covering the epididymis. They are delicate in structure, contain a clear limpid fluid, and are very liable to rupture. They are met with at all ages after that of puberty. According to Gosselin, after the age of forty, they occurred in at least two-thirds of the testes examined to ascertain their presence. Such cysts as these may remain stationary, of small size, and not to be detected during life, being merely pathological phenomena; they may rupture into the tunica vaginalis; or they may enlarge and become developed into tumors of considerable magnitude.

The fluid of these cysts possesses the remarkable characteristic discovered by Liston, of containing spermatozoa (Fig. 615); an observation that has been fully confirmed by many subsequent observers. Though spermatozoa do not always exist in this fluid, yet they are usually met with, sometimes in small quantities, at others so abundantly as to give a turbid or opalescent appearance. This admixture of spermatozoa with the clear fluid of the cyst is probably due, as pointed out by Curling, to the accidental rupture of a seminal duct into an already existing cyst. Spermatozoa have also, but very rarely, been found in the fluid of an ordinary hydrocele of the tunica vaginalis; and then probably their presence was due to the rupture of one of these cysts into the tunica vaginalis. Hence their presence in the fluid of hydrocele may in most cases be considered as characteristic of the encysted variety of the disease.

Fig. 615.



Spermatozoa from encysted hydrocele.

The *symptoms* of encysted hydrocele differ in some respects from those presented by the ordinary form of the disease. The tumor of the encysted variety is smaller, more irregular in shape, and does not envelop the testis completely, but is situated behind it, and rather in connection with the epididymis.

The *treatment* consists in injecting the sac with tincture of iodine, or in incising the tumor and allowing it to granulate from the bottom. The injection by iodine, though successful in some cases, is not so frequently so in this as in the last variety of the disease, but usually deserves a trial; if it fail, the incision of the tumor will always effect a cure.

Hydrocele of the Cord.—This disease is characterized by the presence of a round or oval tumor, situated on the cord, below or within the inguinal canal. It is smooth, elastic, and, if of sufficient size, may be semi-transparent on examination by transmitted light. It can be pushed up into the abdomen, but receives no impulse on coughing, and does not alter in size on being steadily compressed. It appears to be formed, in some cases, by the funicular portion of the peritoneal investment of the cord being imperfectly closed and consolidated at points; though it is possible that in other instances it arises as a distinct cystic growth. These tumors may occur at all ages, but are chiefly met with in the young, and are not unfrequent amongst children.

Treatment.—The obliteration of the cyst is best conducted by passing a seton through it, or by making an incision into it, and letting it granulate from the bottom.

Diffused Hydrocele of the Spermatic Cord consists in the infiltration of the cord with serous fluid, contained in rather distinct cells, and giving rise to an oval or oblong irregular circumscribed tumor, extending below and into the inguinal canal.

The *treatment* consists in the application of blisters, or of counter-irritant plasters. Should the disease prove very troublesome, an incision might be made down to and into the swelling, so as to let out the fluid and allow the cyst to become consolidated.

Hæmatocele.—By *hæmatocele* is meant an accumulation of blood in the tunica vaginalis, distending that sac, and compressing the testis. It is of two kinds, *traumatic* and *spontaneous*. The *traumatic* is the most common form of the disease, usually arising from a blow on or a squeeze of the testis, by which one of the veins ramifying on the surface of the gland is ruptured, and blood is poured into the tunica vaginalis. It may also arise in tapping a hydrocele, from the point of the trocar being pushed too directly backwards and puncturing the testis. *Spontaneous hæmatocele* is a disease of rare occurrence, arising apparently from the rupture of an enlarged spermatic vein into the tunica vaginalis. It attains a larger size, and is altogether a more formidable affection, than the traumatic hæmatocele.

Characters.—In whatever way occurring, a hæmatocele slowly but gradually increases in size, until it attains about the magnitude of a duck's egg, or even that of a cocoanut. It is seldom that it becomes larger than this; but cases are recorded in which the tumor has attained an enormous magnitude. I once operated in a case in which a spontaneous hæmatocele had existed for six years; it was as large as a good-sized melon, and contained, besides about a quart of dark thin blood, a handful of partially decolorized and tough fibrine, the greater portion of which was firmly adherent to the inside of the greatly thickened tunica vaginalis in filamentary and laminated masses, with here and there nodules interspersed. The whole of the interior of the tunica vaginalis closely resembled an aneurismal sac.

The fluid contained in the hæmatocele, when the disease is recent, consists of pure blood; but, when of old standing, it is of a dark and grumous character owing to disintegration of the blood-corpuscles. It then usually contains an admixture of cholesterine. The blood so effused will continue fluid for years; but at last it may decompose and set up fatal inflammatory mischief; in some rare instances the tumor becomes partly solidified by the deposit of masses of fibrinous coagulum, lining the interior of the tunica vaginalis, which are sometimes decolorized and arranged, as in the case just referred to, and in one recorded by Bowman, in a laminated manner, like the contents of an aneurismal sac.

Symptoms.—These are generally sufficiently obvious. The occurrence of the tumor subsequently to a blow, strain, or injury when traumatic, its gradual increase in size, its somewhat heavy but semi-elastic feel, its pyriform shape, and the absence of transparency, together with the freedom of the cord above and the want of impulse in it on coughing, will indicate its true character.

Fig. 616.

Hæmatocele with thickened tunica vaginalis and adherent fibrinous deposit.

Diagnosis.—Hæmatocele of the tunica vaginalis may be confounded with inguinal hernia; from which it may be distinguished by attention to the signs described at pp. 977 and 978.

Treatment.—This must vary with the size and duration of the tumor. When it is small and recent, and has fluid contents, the surgeon may try the effect of tapping it; it is possible that, after the evacuation of the blood, closure and obliteration of the tunica vaginalis will take place. This happened in a case under my care, in which, though the disease had existed for three years, a complete cure followed the operation of tapping. Such simple treatment as this, however, cannot be depended upon; and it usually becomes necessary to lay the sac open, and to cause it to contract and to granulate from the bottom, when the obliteration of the cavity of the tunica vaginalis necessarily results. If the tumor were of very large size, and the tunica vaginalis much thickened, hardened, and parchment-like, with adherent and

necessary in consequence of these conditions, and was successfully done.

Hæmatocele of the Spermatic Cord has been observed by Pott, Curling, Bowman, and others; it is a rare disease, and usually occurs in the form of tumor of considerable magnitude, suddenly arising after a strain or some violent exertion, giving rise to the rupture of a varicose spermatic vein. It commences in the inguinal canal, and thence extends downwards along the course of the cord, through the abdominal ring into the scrotum; but it does not surround or implicate the testis, which can be felt free and movable at its lowest part. On incising such a tumor as this, a quantity of blood, partly fluid and partly coagulated, has been found, sometimes contained in a cavity, occasioned by the laceration and separation of the tissues of the cord and scrotum. The most remarkable case of this kind on record is one related by Bowman, in which the tumor, after existing for ten years, had attained so enormous a size, that it reached to the patella, and was so heavy as to require both hands and a considerable effort to raise it from its bed. In this case, death appears to have resulted from decomposition of the contents of the tumor.

Diagnosis.—In its early stages, hæmatocele of the cord would run considerable risk of being confounded with an *inguinal hernia.* The more diffused character of the swelling, however, its irregular feel, its semi-fluctuating sensation, and the impossibility of reduction, might enable the diagnosis to be made (p. 978). Hæmatocele of the cord may always be distinguished from an accumulation of *blood in the tunica vaginalis*, by the testicle not being implicated in the former case, but surrounded by the fluid in the latter instance.

The *treatment* of this disease must in the earlier stages be of a palliative kind; consisting in rest, support of the tumor, and the application of evaporating lotions. Care should be taken not to incise it at this period, lest the loss of blood from the ruptured vein, after the evacuation of the contents of the tumor, become uncontrollable. In one instance I have known fatal consequences from this cause to ensue in half an hour after making an incision into the tumor and turning out the coagula. When, however, the disease has reached a chronic stage, and is no longer increasing, it may be incised; and, its contents being turned out, the cavity may be allowed to suppurate and granulate.

VARICOCELE.

Varix, or *enlargement of the spermatic veins*, is a disease that is commonly met with from the age of puberty to about the thirtieth year, seldom commencing later than this. It usually occurs in feeble individuals having the scrotum lax and pendulous; and in some cases appears to have been brought on by venereal excesses. The spermatic veins, extending as they do from opposite the upper lumbar vertebræ to the plexus pampiniformis, which constitutes the base of the pyramidal tumor formed by a fully developed varicocele, are necessarily subject to considerable outward pressure from the weight of so long a column of blood as that contained within them, to which they eventually yield, becoming much dilated and tortuous. The left spermatic veins are far more frequently affected than the right; partly owing to their compression by feculent accumulations in the sigmoid flexure of the colon, and partly to the obstacle at the mouth, occasioned by their pouring their contents into the left renal vein, at right angles to the current of blood flowing through that vessel into the vena cava. The right spermatic veins are rarely affected; and never, I believe, without those on the left side participating in the disease. In these cases of double varicocele, the left is almost invariably the more seriously affected; but I have seen exceptions to this in one or two instances, in which the veins on the right side formed the larger tumor.

[Another reason for the greater frequency of varicocele upon the left side, is that the right spermatic vein is provided with a valve at its entrance into the vena cava, which valve is wanting upon the left side. (Brinton, in *American Journal of Medical Sciences*, July, 1856.)—A.]

Symptoms.—The symptoms of varicocele consist of a tumor of pyramidal shape, having a knotted or knobbed feel, owing to the irregularly swollen and convoluted condition of the veins, with its base upon the testis and the apex stretching up to the external ring. The swelling increases when the patient stands up, if he take a

deep inspiration, cough, or make any violent exertion. Its size [illegible] fulness of the veins to a large mass, several inches in circumference, [illegible] When the patient lies down, it goes up to a certain extent, but [illegible] to its former magnitude when he stands up again. It is [illegible] of weight and sometimes of pain, which is occasionally [illegible] neuralgic character, even in the scrotum, the testicle being [illegible] when the tumor is unsupported. This pain is greatly [illegible] necessary exercise, and is prevented from occurring [illegible] of the generative organs, with a tendency to an [illegible] depression, frequently accompanied with [illegible] occur from external injury, giving rise to an [illegible] the areolar tissue of the scrotum. Of this [illegible] known this to be attended with [illegible] an enormous extravasation of blood into the [illegible] of coagula having been turned out, hemorrhage [illegible] which he was admitted into the hospital. The [illegible] expression, "had been frightened by a varicocele" [illegible] became faint and died of venous apoplexy, [illegible] ceeded from a ruptured spermatic vein.

Diagnosis.—The varicocele is always [illegible] feel its broad base and narrow apex, when he stands [illegible] patient lies down, and returns again, when he [illegible] it from all other scrotal tumors. From inguinal [illegible] tinguished by attention to the test described at page [illegible]

Treatment.—The treatment of varicocele [illegible] severity of the symptoms occasioned by it, and [illegible] as is usually the case, it gives rise to but slight [illegible] is fully sufficient; but if, as occasionally happens, [illegible] intense suffering, or tend to the induction of [illegible] debility, with much mental disquietude, the [illegible] feel disposed to endeavor to cure the varicocele [illegible] The palliative treatment of varicocele consists [illegible] having for their object the support of the scrotum [illegible] and of the consequent pressure, of the testis [illegible] veniently done by supporting the scrotum on the [illegible] pressure may be made upon the testis, or [illegible] testis in an elastic bag. In other cases, a [illegible] lower portion of the scrotum has been [illegible] metal, covered with leather, or the cord [illegible] ring, so as to shorten the cord. [illegible] portion of the scrotum has been [illegible] cicatrix, the testis may be pressed [illegible] This plan, however, is somewhat [illegible] porary benefit, the advantage [illegible] pressure of the pad of a truss [illegible] ring, will break the length of [illegible] service in some cases, though [illegible] instrument.

In addition to these [illegible] sea-bathing, and the [illegible]

The radical cure [illegible] by compressing [illegible] us in the management [illegible]

The circumstances for [illegible] disease can be arranged in [illegible]

1. When the existence of [illegible] the public services, there is [illegible] operating. One of the cases in [illegible] in the prime of life, who, wishing [illegible] ground of having a small varicoce [illegible] wards entered the service.

The diagnosis of scrotal tumors is not only of considerable importance, but is often attended with very great difficulty; the more so, as they are frequently associated with one another, so that much tact and care are required to discriminate their true nature. Thus it is not uncommon to find a hydrocele and a hernia; a hydrocele and a varicocele; or these affections coexisting with a solid tumor of the testicle. In other cases, again, as in the annexed figure (625), an encephaloid tumor may coexist with a hydrocele of the tunica vaginalis, and with an encysted hydrocele of the cord.

Fig. 625.

Encephaloid testicle with hydroceles of the tunica vaginalis and of the cord.

Tumors of the scrotum may, in a diagnostic point of view, be divided into two distinct classes: 1, the reducible; and 2, the irreducible.

1. **Reducible Tumors.**—These are hernia, congenital hydrocele, diffuse hydrocele of the cord, and varicocele; in all of which the swelling can be made to disappear more or less completely by pressure and by the patient lying down; reappearing on the removal of the pressure, or on his assuming the erect posture. The mode in which the tumor disappears tends greatly to establish its diagnosis; though the general character of the swelling, and the history of the case, afford important collateral evidence on this point.

a. In *hernia* there are the ordinary signs of this affection, such as impulse on coughing, &c. On reducing the tumor it will be found that its return into the abdomen is accompanied by a gurgling noise, and by the sudden slip upwards of evidently a solid body. In the other reducible tumors, the diminution and eventual disappearance under pressure are more gradual, and there is no reduction of the mass as a whole.

b. The gradual squeezing out of the contents of a *congenital hydrocele* together with its translucency, and the early age at which it occurs, will establish its true character.

c. In the *diffuse hydrocele of the cord*, there is an uniform semi-fluctuating swelling in and near the ring; in which, however, there is no gurgling, &c., no complete and sudden disappearance as in hernia. It is also less defined, and has a less distinct impulse on coughing.

d. Varicocele may always be distinguished by its pyramidal shape, and its knotted, soft, and irregular feel. After being reduced when the patient lies down, it will, when he stands up, fill again, even though the surgeon compress the external ring with his fingers. This sign, which distinguishes it from a hernia, occurs also in hydrocele; from which, however, the varicocele may be distinguished by the absence of translucency, the want of fluctuation, and the general feel of the tumor.

2. **Irreducible Scrotal Tumors** are of various kinds; such as omental hernia, hydrocele, hæmatocele, the various forms of sarcocele, and cancer of the testicle. These tumors, though presenting certain characters in common, yet differ somewhat in the predominance of particular signs. Thus, the shape of the tumor is usually pyriform in hydrocele, globular in hæmatocele, and oval in sarcocele; though this is subject to much variation. The weight is least in hydrocele and greatest in sarcocele, proportionately to the size of the tumor. The characters of the surface present considerable differences, being smooth and tense in hydrocele and hæmatocele; often irregular, hard, or knotted in the other varieties. The rapidity of the formation of the tumor is greatest in hæmatocele.

a. Irreducible scrotal hernia may be recognized by its irregular feel, by its impulse on coughing, by its occupation of the canal, and by the testicle being distinctly perceptible below it.

b. Hydrocele of the tunica vaginalis is always recognizable by its translucency; and the amount of opacity conjoined with this will enable the surgeon to distinguish the degree of enlargement of the testis, and how far there is a sarcocele conjoined with it.

c. In *hæmatocele* the tumor is of sudden or rapid formation, somewhat globular, opaque, but not very heavy or hard, and smooth upon the surface.

d. In *sarcocele* generally the tumor is heavy for its size, frequently globular or irregular in shape, sometimes knobbed, and usually attended by a good deal of dragging pain in the groin, and frequently by some enlargement of the cord.

The point of most importance in the diagnosis of sarcocele is to distinguish the *malignant* from the *non-malignant* varieties. In the malignant the rapidity of the growth, the softness and the elasticity of the tumor, the implication of one testis only, and the early enlargement of the cord, with its indurated and knobbed condition, are important signs; especially if the disease occur in young men. In a more advanced condition, the softening of the swelling at parts with a tuberous condition of the rest, and the occurrence of fungus with speedy constitutional cachexy, will point to the malignant nature of the tumor. In cases of much doubt and difficulty an exploratory puncture may be made, when the contents of the groove in the needle or of the fine canula will probably determine the character of the growth. In more than one instance, in which there was much obscurity, I have seen the true nature of the disease cleared up in this way.

IMPOTENCE AND SPERMATORRHŒA.

Various forms of debility, of loss of power, or of irregularity of action in the generative organs, are confounded together under the terms *impotence* and *spermatorrhœa*. These conditions require a more careful consideration on the part of the educated surgeon than they have hitherto received, as their existence is a source of the deepest mental depression and distress to the sufferer. It is certainly one cause of conjugal infidelity, and occasionally of suicide. These affections, which are of extreme frequency amongst all classes of the community, having scarcely as yet received that attention on the part of the profession generally that their importance deserves, the unfortunate sufferers from them are too often driven into the hands of those pestilent quacks that flourish in the metropolis, and infest almost every town in the country, and by whom they are not unfrequently ruined in health as well as in purse.

We may, I think, recognize at least three distinct varieties of generative debility and impotence: 1, true spermatorrhœa, or seminal flux; 2, spasmodic spermatorrhœa, or spermaspasmos; and, 3, that arising from want of seminal secretion, or asperma.

1. **True Spermatorrhœa**, or **Seminal Flux**, is chiefly met with in young men usually from the ages of eighteen to thirty. It is commonly the consequence of masturbation in boyhood, of debility of the generative organs induced by gonorrhœa, or of the continued struggle to repress the natural sexual desires by a life of forced or unavoidable continence. In this form of the disease there is a mixture of irritabilty and of debility. The generative organs are excited by slight emotional causes, or by trivial and ordinary physical stimuli—a thought, a look, a word, the movement of a carriage, the effort of straining at stool, will excite the secretion of the testes, which the debilitated state of the parts allows to escape with a feeble ejaculatory effort. In the slighter cases, and in the earlier stages of the disease, these emissions take place but occasionally—three or four times a week, chiefly in the morning, in the mid state between waking and sleeping, and are preceded by an erection. In the more advanced stages, the emissions occur once or oftener in the twenty-four hours without an erection; the semen at last, when discharged, flowing back into the neck of the bladder, escaping with each discharge of the urine, or being squeezed out after defecation. The patient's physical and mental state becomes seriously implicated in these cases of true spermatorrhœa. His countenance is pallid, anæmic, and sallow; his features are drawn; his eyes lifeless; his spirits depressed, often to the lowest depths of despondency and despair. Connection is impracticable, as the discharge of semen takes place before erection occurs.

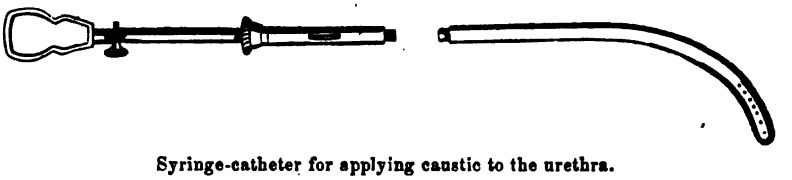
[It must not be forgotten that distension of the vesiculæ seminales acts as an excitant to the ejaculatory apparatus, and that hence occasional involuntary emissions are not in any degree inconsistent with a state of perfect health. This fact was recognized as long ago as the days of Lucretius. Indeed, during early manhood, noctural emissions may be considered an almost necessary accompaniment of virtuous celibacy.—A.]

Diagnosis.—This form of spermatorrhœa is apt to be confounded with *prostator-*

rhœa (p. 1103); but the diagnosis may always be effected by a microscopical examination of the discharge.

Treatment.—The curative treatment should consist in giving tone to, and in lessening the irritability of, the genito-urinary organs. In these cases it becomes necessary to maintain and improve the tone of the system by remedies calculated to remove the anæmia and to stimulate the nervous energies. With this view, the preparations of iron, phosphorus, nux vomica, and cantharides will be found the most effective. The syrup of the phosphate of iron and strychnine, or the tincture of the perchloride of iron, in combination with those of nux vomica and cantharides, will be found of the greatest service. But under any form of treatment the cure will be slow, and long-continued perseverance in the use of remedies, local and constitutional, is imperatively necessary. In addition to these means the cold hip-bath should be assiduously employed. This the patient should use every night and morning; remaining in it, at first, for about three minutes, but gradually increasing the time of immersion to ten or fifteen. In some cases the cold shower-bath appears to give more tone, and then should be preferred. These means, useful as adjuncts, will not, however, cure the patient. For this purpose, the local irritability must be removed by the application of the nitrate of silver to the prostatic and bulbous portions of the urethra. It will usually be found that there is a good deal of tenderness in these situations, felt on pressing upon the perineum, or on passing an instrument into the urethra, when, as the point enters the bulb, the patient will suffer much pain. The continuance of this irritation certainly keeps up the seminal emissions, and thus maintains the debility of the genital organs, and the nervous irritability that are so characteristic of these cases. It may most effectually be remedied by the application of the nitrate of silver, as originally recommended by Lallemand; and, if this be done in a proper manner, a cure will usually be accomplished. For many years past I have employed with much advantage in such cases, the instrument here figured (Fig. 626). It consists of a silver catheter, having about a dozen minute apertures near the end. In the interior is contained a slender piece

Fig. 626.



Syringe-catheter for applying caustic to the urethra.

of sponge about two inches long, fixed to the expanded end of a firm stylet that moves within the catheter. The instrument is charged by filling the sponge with some solution of nitrate of silver by withdrawing the stylet. It may then be well oiled; and, being passed down to the spot to be cauterized, the solution is forced out of the aperture by pushing down the rod, which compresses the sponge. I have found this syringe-catheter far safer and more manageable than Lallemand's or any other *porte-caustiques* that act by protruding a spoon or sponge, which is apt to be grasped by the spasmodic action of the muscles of the part, often being returned with difficulty into the shaft, and not without risk of lacerating the mucous membrane. I generally use a solution of the strength of ʒj of the nitrate to an ounce of water; though sometimes only a half or a third of this strength can be borne. The application usually occasions a good deal of irritation for a time, sometimes even a muco-purulent discharge, and can only be repeated at intervals of from ten days to a fortnight. Any undue amount of irritation must be subdued by ordinary antiphlogistic treatment.

2. **Spasmodic Spermatorrhœa, or Spermaspasmos,** more frequently occurs between the ages of twenty-five and forty. It is frequently predisposed to by residence in a warm climate, or by the existence of some disease about the generative organs; such as stricture, varicocele, neuralgia testis, &c. In these cases there is not, properly speaking, a seminal flux; but connection cannot be effected, as erection and ejaculation are either simultaneous acts, or the erection subsides before the emission takes place.

Treatment.—This is a condition of irritability rather than of debility. It often

Hence tonics are not necessary; nor, indeed, would they be in any way usef

The remedy most to be relied upon is the bromide of potassium in com with camphor and belladonna, with cold bathing, and perhaps, when there i irritation, blisters to the perineum and along the penis. In addition to th it is of the first importance to enjoin abstinence in food and drink; for these cases, it will be found that abdominal plethora coexists, and exer rious influence.

3. **Impotence** arising from absence of all sexual desire or powe mature decay of that power, is not unfrequently met with, and oft who are otherwise strong and healthy; sometimes, indeed, in those great muscular power, and much given to athletic exercises. Th desire may be looked upon in many instances as a natural defic zation of the individual, for which medical or surgical treatme other cases, it arises from exhaustion of the nervous system or mental exertion, carried to a too great and injurious degr of seminal secretion—*asperma*—except in cases of atrophy must be especially rare. In a patient of mine who died at according to his own and wife's account, had been com twenty-four preceding years, spermatozoa in considera death found in the testes, which were carefully examine taining whether they ever secreted semen.

Sterility in the male is a condition that has attrac of late years. It may occur independently of any of described, in individuals, indeed, who are possessed of sexual desire and vigor. It would appear to b of the seminal fluid, in consequence of which the sp are possessed of insufficient vitality to effect impr dition are very obscure; but chronic gleet and epi most frequent. The only *treatment* that could b cess, would be the removal of any local disease

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CHAPTE

DISEASES OF THE FE

SOME of the more important surgi vesical and recto-vaginal fistulæ, l syphilitic disease to which they remaining affections, implicating th siderable practical interest; but, a the limits that can be assigned to brief indication of the principal

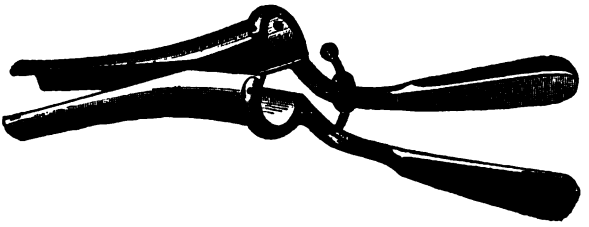
INTROD

Speculum Vaginæ.—V monly used by surgeons. V the most convenient instr lum (Fig. 627); which, bei always presents internal thrown into the bottom cleanly, and not staine should be of different the inner end. Wher rations for fistula, a

Fig. 627.

Cylindrical speculum.

Fig. 628.



Bivalve speculum.

Fig. 629.

Branched speculum.

[A good form of bivalve speculum is that known as Cusco's, which has been recently usefully modified by Dr. Getchell, of this city. (*Transactions of the College of Physicians*, in *American Journal of Medical Sciences*, April, 1867, page 435.) Another ingenious form of bivalve speculum has been described by Dr. J. S. Hough (*Ibid.*, July, 1869, page 284).—A.]

[Fig. 630.

Cusco's speculum.]

Introduction of the speculum may readily be effected, without any exposure of the person, under the dress or bed-clothes. There are two positions in which the patient may conveniently be placed for this purpose: In the first, she lies upon her back, with the nates well raised or brought to the edge of the bed or couch, her legs separated, and her feet resting on two chairs; the surgeon, standing or sitting in front of the patient, introduces the fore and middle fingers of his left hand into the vagina, dilates its walls, and passes the speculum, well greased, gently and steadily between and under them. This position is the most convenient when caustics require to be applied, but is often objectionable to the patient, as it appears to entail much exposure, though in reality it need not do so. Another mode of introducing the speculum, which should always be adopted when practicable, consists in placing the patient on her left side across the bed, with the knees drawn up, and the nates near the edge; the instrument is then introduced in the same way as before, the surgeon sitting by the patient's side. In whichever way the speculum is used, no force should ever be employed; the patient should be placed opposite a good light, and care should be taken that the instrument be introduced fairly to the uterus, the position of which may have been previously ascertained by tactile examination.

Female Catheter.—The use of the female catheter is often required in various diseases and operative procedures about the genito-urinary organs of women. It should be introduced without exposure, by the aid of the touch alone. This may readily be done, as the patient lies in bed, under the clothes. The surgeon, standing on her left side, passes his left index finger downwards between the nymphæ until he feels the projection of the meatus urinarius, immediately above the entrance

into the vagina; keeping his finger just below this, he uses it as a guide to direct the point of the catheter into the canal.

DISEASES OF THE EXTERNAL ORGANS AND VAGINA.

The vulva and the nymphæ are the seats of numerous morbid conditions, principally consisting of hypertrophy or of verrucous growths from them, or the formation of cysts in their substance.

Hypertrophy of the Labia to a limited extent is not unfrequently met with, one labium hanging down considerably below the other. In these cases, it will often be found that the enlargement is due to a kind of solid œdema, originally dependent perhaps upon a fissure or ulcer of the part. In other cases, large fibro-cellular tumors form as outgrowths from the natural structures in this region; these may require removal by simple excision.

Large Condylomata or **Verrucæ** are often met with here, as the result of gonorrhœal or syphilitic disease, forming at last irregular pendulous masses, which require extirpation, either by knife or scissors. I have had occasion also to remove a large *nævus* by ligature from this situation; and, in fact, almost any growth that occurs in the fibro-cellular tissue may be met with here.

Cystic Tumors are not unfrequently met with in the labia, and may sometimes resemble rather closely the ordinary forms of inguinal hernia; with which, however, their incompressibility, irreducibility, and the absence of impulse on coughing, will prevent their being confounded. These cysts, which require removal by a little simple dissection, usually contain a dark, turbid, or sanguineous fluid, and sometimes atheromatous matter. Tolerably free hemorrhage may follow their removal, the excitable tissues of the labia being cut into. This may, however, always be arrested by pressure and a T-bandage. Occasionally they project from the inside of the vagina, and then require removal by dissection or ligature, as can be best practised.

Imperforate Vagina is occasionally met with in young children, and occasions a good deal of anxiety to the parents. This condition, however, may always be very readily and speedily removed by tearing open the canal, as it were, by dragging open its walls in opposite directions, and breaking through the adhesions, which are little more than epithelial, with the thumb nail, a blunt probe, or the handle of a scalpel, and then introducing a small pledget of greased lint.

Imperforate Hymen is occasionally met with, causing great inconvenience, and even danger, by the retention of the menstrual secretion, which may accumulate to an immense extent, and become converted into a kind of chocolate-colored grumous fluid. This malformation does not usually attract attention until the age of seventeen or eighteen. When the menstrual flux has, however, not appeared, notwithstanding periodical constitutional disturbance, an examination is instituted and the cause of the obstruction is revealed. In these cases the hymen, which forms a dense elastic membrane, is pushed down between the nymphæ, and the accumulated secretion may sometimes be felt as an elastic fluctuating tumor above the pubes or in the iliac fossa.

The *treatment* consists in puncturing the hymen with a trocar, enlarging the opening with a probe-pointed bistoury, and discharging the retained fluid, which may be in very large quantity. This operation is not always unattended by danger. Suppuration of the exposed cavity and peritonitis may come on, ending in the patient's death. In opening the membrane, it need scarcely be said that wounds of the urethra should be carefully guarded against; and, with care, that canal may always be avoided. I have, however, seen one case in which it had been slit up by the surgeon who punctured the membrane.

[MM. Bernutz and Goupil have shown that death in these cases is very often due to escape of blood into the abdominal cavity through the Fallopian tubes. To obviate this, they advise the puncture to be made with a small trocar and canula, a piece of tubing being attached to the latter through which the retained fluid may very gradually drain away. The puncture should be made eight or ten days *after* a menstrual period, and no pressure should be made upon the abdomen during the process of evacuation. (*Dis. of Women*, Syd. Soc. ed., vol. i. p. 131.)—A.]

Occasionally the surgeon's advice may be sought by married women, for a rigid and only *partially perforate hymen;* when incision with a probe-pointed bistoury

unruptured, though in most cases it gives way under the pressure of the fœtal head.

Absence of the Uterus and Ovaries, with imperforate vagina, is occasionally met with in women, otherwise perfectly well formed: the external organs of generation, labia, and nymphæ being present, and the breasts developed. In such cases, it is remarkable that sexual desire usually exists. The true condition may, however, be detected by an examination *per rectum*, and especially by the introduction of a catheter into the bladder whilst the finger is in the rectum, when the two cavities will be found to be in close apposition without the intervention of uterus or ovaries, the point of the instrument being felt thinly covered through the gut. In two of the cases of this kind in which I have been consulted, there had been monthly epistaxis. No surgical interference can be of any avail in such cases; and an attempt to restore the vagina would necessarily lead to fatal results by opening the peritoneal cavity. Occasionally, if the woman have been married, the fruitless attempt at coition on the part of the husband has caused dilatation and expansion of the urethral orifice to such an extent, that the index finger may be introduced into the cavity of the bladder; and I have known this expanded urethra mistaken for the vaginal aperture, coitus effected into it, and the existence of the malformation for a time completely overlooked. *Simultaneous* vesical and rectal exploration will always clear up the true nature of the case.

Hypertrophy of the Clitoris is occasionally met with; this organ becoming enlarged, elongated, and pendulous, and in some cases attaining an enormous size. Hargrave mentions an instance where it was found after removal to constitute a tumor weighing five pounds and a half. When the clitoris is enlarged, it may give rise to a good deal of irritation, and require excision, an operation that is often followed by rather troublesome hemorrhage, requiring the use of the actual cautery for its arrest.

Removal of the clitoris, even though not enlarged, has of late years been recommended and extensively practised as a means of cure in some forms of epilepsy and of erotomania. This is an operation as unscientific as it would be to remove the glans penis for the cure of similar affections in the male, and one that the experience of the profession has proved to be as useless as it is unscientific.

Tumors of various kinds are met with in the interior of the vagina, springing from its walls. These may be of a *cystic* character; but occasionally true *mucous polypi* are found dependent and projecting from the side of this canal. These may most readily be removed by transfixing their base by a double whipcord ligature, and then strangling it. In performing this operation, however, when the tumor grows from the posterior wall, care must be taken to ascertain by proper digital examination, that a portion of the rectum has not been dragged down into its base.

Prolapsus of the anterior or the posterior wall of the vagina may occur, giving rise, in the first instance, to protrusion of the bladder, or *cystocele;* in the other, to a *rectocele*. In either case, but especially in the first, it occasions very serious and troublesome consequences, amongst which chronic irritation of the mucous membrane of the bladder, with perhaps phosphatic deposits in the urine, are the most marked. These protrusions may be supported by the use of properly constructed belts or pessaries.

In some cases the surgeon may feel disposed to undertake plastic operations, in order to narrow the vaginal orifice by freely paring the opposite portions of its wall bringing together the freshened surfaces by means of the quilled suture, and thus procuring narrowing of the canal and permanent support to the protruded part. The success of such operative proceedings will greatly depend on attention to details. The mucous membrane at the orifice of the vagina should be dissected off from about half an inch below the meatus on one side, to a corresponding part on the other, in a strip about an inch and a half wide; the dissection being carried well up posteriorly in the fourchette. Two or three deep, and as many superficial, sutures should be passed; the deep being left in for about five, the superficial for seven, days. Great attention should be paid to cleanliness, the patient lying on her side with a catheter in the bladder communicating with an India-rubber tube to carry off the urine; and the bowels should be confined by opium.

Various Discharges connected with the female organs of generation fall under

the observation of the surgeon; these may occur from the external organs, from the mucous membrane covering the cervix uteri, or from the interior of the cavity of that organ. These discharges, when proceeding from the mucous membrane covering the external organ, or lining the vagina, are frequently, though not necessarily, of a gonorrhœal character; and then require to be treated in the way that has been mentioned at page 1113. When they are of a simple nature, proceeding from mere excessive secretion of these parts, astringent injections, and attention to the general health, will usually succeed in effecting a cure.

When these discharges proceed from the cervix or the interior of the os uteri, they will commonly be found to be dependent upon a chronically inflamed or congested condition of the organ, or upon a papillated, granular, fissured, or ulcerated condition of the mucous membrane, often connected with more or less local thickening and induration of subjacent structures. These various conditions, often of a very persistent, insidious, and destructive character, have of late years been fully recognized by the labors of some of the French surgeons, more particularly of Lisfranc, Emery, and Jobert; and in this country their pathology has been greatly elucidated by Simpson and Bennett. To Bennett especially is due the great credit of having pointed out the true pathology of various uterine diseases that were previously but imperfectly recognized, and of having shown that many of the so-called functional diseases of the uterus are in reality dependent upon congestion, inflammation, and other structural lesions of this organ.

Symptoms.—These uterine discharges, occurring usually as the result of chronic inflammation and its consequences, just as we find on other mucous surfaces, as those of the urethra, throat, or eyelids, are attended by various symptoms indicative of local distress: such as pain in the back and thighs, and more especially in the left groin, with dysmenorrhœa, and usually a good deal of sympathetic constitutional irritation, terminating in impaired digestion, malnutrition, and anæmia. It is in this condition of the system that many of the so-called hysterical affections are so apt to arise; and the surgeon will often find that the most inveterate cases of neuralgia of the joints, the spine, the hip, or the breasts, and of amaurotic and other obscure affections connected with nervous irritation, are primarily dependent on chronic uterine disease: and it is only by attacking and removing this, that he will remedy the secondary mischief. On examining the condition of the cervix and os uteri in these cases by means of the speculum, various morbid changes will be observed in them; the cervix is perhaps thickened, indurated, or knobbed on one side; the os is frequently patulous; and the mucous membrane covering these parts will be observed to be erythematous, congested, and perhaps excoriated, not unfrequently in a granular condition, closely resembling what may be observed in some forms of granular conjunctivitis. In other cases, again, true ulceration may exist both upon the cervix and within the os. These ulcers, abrasions, excoriations, or by whatever term they may be designated, are unquestionably a fruitful source of mischief in this situation, giving rise to considerable thickening of subjacent structures, and usually to abundant muco-purulent discharge and much sympathetic irritation. In character they closely resemble corresponding forms of disease met with on the mucous surface in other situations, not attended by loss of substance, but by the development of small pointed granulations or papillæ, from which the discharge is poured forth.

The *treatment* of these various affections of the uterus has been materially simplified since their pathology has been better understood; and practitioners are now generally agreed as to the necessity of the employment of energetic local measures for the removal of these morbid states. To the surgeon who is in the habit of managing local disease on other mucous surfaces, and of removing the structural lesions that result from chronic inflammation in other organs, the treatment of these cases can present little difficulty, as it is conducted on precisely the same principles that guide him in the management of similar affections elsewhere.

The employment of caustics is of essential service in these various forms of chronic uterine disease. In cases of simple ulceration or excoriation, the nitrate of silver in stick, applied every third or fourth day, will frequently be found to effect a speedy cure. For this purpose, the hinge caustic-holder will be found a useful instrument. If there be much chronic induration, conjoined with the affection of the mucous membrane, the potassa cum calce, fused into narrow sticks, may very advantageously be used. In doing this, however, care must of course be taken that the

applications, which should only be repeated at lengthened intervals, the patient must be kept quiet for some time; and any inflammatory symptoms that may be excited must be combated in the usual way; it very rarely happens, however, that anything untoward will result.

After the removal of the local disease in the way pointed out, any remaining congestion may be got rid of by the application of leeches to the cervix. During the time when these local measures are being adopted, recourse must be had to proper constitutional treatment, with the view of improving the general health on ordinary medical principles. The details of this treatment need not be given here; but for a full exposition of them, as well as for a vast deal of important information on the surgical management of uterine affections, I would refer the reader to the last edition of Bennett's work on the Uterus.

Uterine Displacement.—The various displacements to which the uterus is liable, whether downwards, constituting *prolapsus*, or in the direction of the axis, being twisted, and either *retroverted* or *anteverted*, are causes of much local suffering and constitutional disturbance, and commonly require surgical treatment. These various conditions will frequently be found dependent on inflammatory congestion of the fundus, in consequence of which the organ becomes, as it were, top-heavy. and is tilted to one side, or descends bodily in the pelvis.

The *treatment* in such circumstances must have reference to the removal of the local turgescence by the application of leeches, the employment of astringents, hip-baths, and the recumbent position; occasionally assisted perhaps, in twist of the organ, by attempts at replacing it by introducing the uterine sound into its cavity, or, when it is prolapsed, by supporting it with appropriate pessaries and the abdominal bandage.

Vaginal Discharges of a purulent character not unfrequently occur in young female children, as the result of constitutional debility or strumous derangement. Occasionally such discharges lead to the suspicion of the child having been improperly tampered with; and, although they might of course be occasioned by some violence inflicted on the genitals, or even from gonorrhœal infection, it must be borne in mind that, in the great majority of instances, they certainly arise from constitutional conditions solely, and are in no way referable to external causes. The *treatment* consists in attention to cleanliness, the use of warm lead lotions, and the improvement of the general health.

Tumors of the Uterus are of various kinds. The most common are those of a *fibrous* character. These are often of considerable size, and have been found weighing many pounds; they may occupy almost any portion of the uterus, either projecting into the peritoneal cavity, occupying the interior of the organ, or dependent into the vagina. These tumors seldom occur before the age of thirty or forty, and are not very amenable to *treatment*. In some cases, however, considerable benefit results from attention to position, the occasional application of leeches to the cervix, so as to lessen the congestion of the organ, and the introduction into the vagina every night of a ball composed of equal parts of strong mercurial ointment, wax, and lard, or one containing iodine or the iodide of lead, with the view of acting as an absorbent on the morbid tissue.

Polypi are not unfrequently met with, growing from the inner surface of the uterus, usually from its posterior aspect or fundus. These growths are generally oval or pyriform, smooth, hard, insensible, and fibrous in structure. They are often the cause of repeated and dangerous hemorrhage; and it is a remarkable fact that in many cases the most violent and persistent bleeding proceeds from the smallest tumors. In other cases, the polypi of the uterus are of a soft fibro-cellular, vesicular, or mucous character, attended, like the harder ones, by free hemorrhage.

Treatment.—Polypi may be removed in various ways: 1. By *torsion*. When the tumor is small and situated within the uterine cavity, a long pair of broad-ended forceps may be introduced through the patulous and turgid os, and the polyp readily twisted off from its attachment. 2. By *excision*. When the tumor is large and pyriform, has an elongated pedicle, and projects through the os, the patient may be placed in the position for lithotomy, and the labia opened and held aside by retractors: the growth may then be drawn down by a large pair of vulsellum-

with a long pair of scissors or a probe-pointed bistoury. After removal, a pledget of lint soaked in a solution of perchloride of iron should be pressed against the stump of the pedicle. If hemorrhage occur, the cut surface may be touched by the actual cautery passed up through a speculum. 3. The pedicle of the polyp, having been brought into view as just described, may be divided by the *écraseur*, the same precautions as to hemorrhage being taken. 4. The pedicle may be *ligatured*. This may either be done by bringing down the tumor as directed above, transfixing its neck with a large nævus needle carrying a double whipcord ligature, and tying it in two halves. In order to prevent the annoyance resulting from the decomposition of the ligatured mass, the pedicle may be cut across immediately under the part to which the ligature has been applied. In some cases the ligature is gradually tightened. This operation is done by means of a whipcord applied by Gooch's double canula, which has been variously modified and a good deal improved by different surgeons. The ligature usually cuts its way through in from three to five days; the tumor swells, and decomposes, often with a good deal of fetid discharge, which requires to be carefully syringed away by means of dilute chlorinated lotions. It is a useful precaution, not to apply the ligature too near the uterine end of the pedicle; as cases have occurred in which, by so doing, the surgeon has given rise to serious and even fatal inflammation of the womb. Any portion of pedicle that is left after the ligature has separated will gradually undergo absorption. Of these various methods, I think that, in the treatment of large polypi, removal by the écraseur, or the transfixion and ligature of the neck of the tumor and the immediate excision of the part below the ligature is the safest, most expeditious, and the best.

Cauliflower excrescence from the uterus, attended by copious discharge, is a rare and dangerous affection. The only *treatment* that appears to be of any avail, is to draw down the neck of the uterus by means of a vulsellum, and then to excise the tumor with the surface on which it grows. This operation is not attended by any very serious hemorrhage, and succeeds in ridding the patient effectually of her disease.

Malignant affections of the uterus usually commence in the form of scirrhous tubercle or ulceration of the cervix, attended by the ordinary local and constitutional symptoms of this affection; there is much offensive discharge, and cancerous cachexy speedily sets in.

The *treatment* of these cases must be of a purely palliative character; the administration of opiates and the use of chlorinated lotions must be principally relied on. Excision of the diseased cervix has been recommended, and was formerly a good deal practised; but this is a barbarous procedure, and contrary to every principle of good surgery, as it is impossible to rid the patient of scirrhous disease by the partial removal of the affected organ, and its complete extirpation cannot be thought of. Tumors, however, of a simple character requiring removal are occasionally met with springing from the cervix; they may be excised by putting the patient in the position for lithotomy, drawing the uterus well down with forceps, and removing them with the knife. This has been done during pregnancy, and even during parturition, with good effects.

OVARIAN TUMORS AND DROPSY.

Ovarian tumors of a cystic character are commonly met with. The cysts may be uni- or multilocular, and vary greatly in the nature of their contents. These may be either solid or fluid—often a combination of the two. If fluid, the liquid is usually more or less viscid, albuminous, dark and variously colored. Ovarian tumor, if left without treatment, invariably ends fatally; in some cases rapidly, in most gradually, occupying many years in its course.

Diagnosis.—It is not my intention to enter into the difficult subject of the diagnosis of ovarian tumors. From pregnancy, ascites, tumors of the uterus and omentum, enlargements of the liver, kidney, spleen, and stomach, hydatids, hysterical tympanitis, fat in the omentum, stercoraceous accumulations, distension of the bladder, spinal curvature, abdominal and pelvic abscesses, the diagnosis has carefully to be made; and that this is a matter of no slight difficulty, is evident from the numerous cases in which errors have happened, and are constantly occurring to most experienced practitioners. It is impossible for the surgeon to be too cautious

closely resembles an ovarian cyst, that I may refer to it; it is *a dilated state of the Fallopian tube, containing fluid*—in fact, dropsy of that tube. This condition may generally be recognized by the tumor being of moderate size, wholly fluid, having deep pelvic adhesions, displacing the uterus and bladder, and drawing up the vagina into a pouch. The displacement is often very remarkable and considerable. I have seen the bladder flattened out and drawn up as high as the umbilicus—the top of the vagina above the pubes. In these cases, the abdominal wall is not so much thinned and expanded as in true ovarian disease. The tumor, which cannot of course be extirpated, is never pedunculated.

Treatment.—The treatment of ovarian tumor may be conducted: 1, by medical means; 2, by tapping; 3, by tapping, conjoined with auxiliary measures; 4, by injection; 5, by extirpation.

1. **Medical Means** exercise no influence in curing ovarian tumors, and but little, if any, in retarding their progress. Specific treatment by means of mercury or iodine has always appeared to me to hasten the progress of the malady, by breaking down the constitutional powers of the patient; and attempts at promoting the absorption of the fluid by purgatives, diuretics, &c., are invariably unsuccessful. An ovarian cyst is a parasitic growth, the tissues of which are not influenced to increased power of absorption by the action of deobstruents on the system generally. The utmost that can be done by medical means in such cases is, to attend to the general health and to support the patient's strength by tonics.

2. **Tapping** in ovarian dropsy may be done as for ascites, through the linea alba; but not unfrequently the tumor presents more distinctly at some other part of the abdominal wall, and may be emptied through the linea semilunaris; or, if multilocular, it may require the trocar to be inserted at different points into its separate compartments. The paracentesis of ovarian cysts should, unless the disease be very acute, always be deferred as long as is compatible with the comfort of the patient; as it is not only followed by speedy re-accumulation of the fluid, and often by rapid exhaustion, few patients surviving the first operation more than three or four years; but is attended by certain special dangers, such as the risk of peritonitis, of exhaustion, or possibly even of the puncture of the bladder, or of a coil of small intestine, which is sometimes adherent to the anterior wall of the ovarian cyst, and may be met with where little expected.

[Spencer Wells has lately shown that the common idea that previous tapping lessens the chance of successful ovariotomy, is erroneous. (*Med. Times and Gaz.*, May 29, 1869.)—A.]

3. **Tapping, Conjoined with Auxiliary Means,** has occasionally succeeded in effecting a cure of the disease. These auxiliary means are of various kinds: firm pressure; incision of the cyst; excision of a portion of its wall, plugging the aperture in it with a tent; the introduction of a catheter or tube; the establishment of a fistulous opening leading into the interior of the cyst, either through the anterior abdominal wall or through the vagina, have all been adopted in addition to simple tapping. However much these different procedures may vary in detail, they are all conducted on one principle; viz., that of causing the gradual contraction of the cyst and the cohesion of its walls—a principle of treatment which is only applicable to unilocular cysts, and hence can only be had recourse to in a small number of cases, and those the simplest, of ovarian tumor. None of these means can be looked upon as curative, so far as ovarian disease is concerned. By means of them the cyst that is chiefly enlarged may be made to collapse and contract. But secondary cysts developed in its wall, or at its base, and whose development has been kept in abeyance by the pressure and absorption of nutrition by the larger cyst, will commonly begin to grow when this has been reduced in bulk, and thus eventually a multilocular tumor may be substituted for an apparently unilocular cyst.

4. **Injection of Tincture of Iodine** has, of late, been successfully employed both in this country and the Continent. After the tumor has been tapped, from four to six ounces of the tincture should be injected through a catheter passed down the canula, and left in. The immediate effect of this injection is the contraction of the cyst; the secondary effect, the effusion of plastic matter within it. In some cases no constitutional disturbance follows; in others, a severe febrile paroxysm, accompanied by intense iodism, the urine and saliva being impregnated with iodine;

cyst collapsing, and the tumor perhaps recurring in another form.

5. **Ovariotomy.**—Ovarian cysts and tumors may require removal, either on account of their large size and the consequent inconvenience occasioned by them, or from their rapid growth exhausting the patient, and threatening a speedy extinction of life. To the British School of Surgery is due the merit of having introduced and established *ovariotomy* in surgery. This operation was first proposed by William Hunter; it was strongly recommended by John Bell, and was first practised by a pupil of his, McDowell, of Kentucky. The first operation that was performed in Great Britain was done by Lizars, in 1823. From this time little attention was paid to it for about twenty years, when it was revived by F. Bird. Since that time, it has, after various fluctuations in professional favor, at last been admitted as an established surgical operation, mainly by the labors of F. Bird, Clay, Spencer Wells, and Tyler Smith. Much discrepancy of opinion has existed amongst practitioners as to the propriety of performing this operation, which has been chiefly condemned on two grounds; 1st, that, as the disease for which it has been proposed is not necessarily fatal, or, at all events, not incompatible with long life, it is not proper to subject the patient to a hazardous procedure for its removal; and, 2d, that the mortality from the operation is so high as not to justify a surgeon in performing it.

With regard to the first objection, it may be stated that ovarian disease is attended by very great discomfort and inconvenience in all cases, that it prevents a woman from discharging the active duties of life, and, amongst the poorer classes, from obtaining a livelihood; and that, so far from being a comparatively innocuous affection, it wastes and enfeebles the patient, interfering seriously with nutrition, and with the actions of the abdominal or pelvic organs, and is not generally compatible with prolonged existence. R. Lee states that about 80 per cent. of the cases that are not operated upon, die within one year and three-quarters after the appearance of the disease. When it grows rapidly, or so soon as it attains such a size as to require tapping, death takes place much more quickly. Safford Lee states that of 46 patients with ovarian disease, who were tapped, 37 died, and only 9 recovered; and that of the 37 who died, more than one-half did so in four months from the first tapping, and 27 out of the 37 within a twelvemonth, and of these 18 were tapped once only. In those who survive, repeated tappings are required at constantly decreasing intervals.

The second objection can have little weight with any practical surgeon. The mortality after ovariotomy is not so high as that after many operations, which no surgeon would hesitate for a moment in performing. It is true that in some of these cases, as in the ligature of the larger arteries for aneurism, speedy death would be the penalty of non-interference; whereas, in ovarian disease, a miserable existence may be protracted for some months after the tumor has attained so great a bulk as to render surgical aid necessary. But in other surgical diseases in which operations of the gravest character are performed without hesitation, as in the removal of the upper jaw for tumor, or in amputation at the hip-joint for tumors of the femur, the same objection would hold good. The disease for which these great and dangerous operations are performed, are not incompatible with some months or even years of painful existence; yet the surgeon does not hesitate to give the patient the chance of a doubtful recovery, in order to extricate him from the miseries of prolonged suffering. It is not necessary, in order to justify an operation even of a dangerous character, that the patient be in *immediate* peril of death. It is sufficient that the death from the disease which it is proposed to remove should ultimately be certain, though it may be delayed by months or years of previous suffering. From this point of view ovariotomy appears to me to be a perfectly proper and justifiable operation, and it presents the advantage of the cure, if practised, being complete and permanent. In it there is no mean; the death is speedy, or the cure complete.

John Clay, of Birmingham, in the appendix to his translation of Kiwisch's *Chapters on Disease of the Ovaries*, has collected from various sources the particulars of 567 cases. Of these, the operation was completed by the removal of the entire ovarian tumor in 425, or about three-fourths; the mortality being 183, or about 43 per cent. In 24 cases, the tumor was only partially removed; of these 14 died. In 13 cases, extra-ovarian (mostly uterine) tumors were removed; the mortality here

ovariotomy in the hands of those who have most extensively practised it of late years—as Baker Brown, Tyler Smith, Spencer Wells, Atlee, and Kœberle—are, however, even more favorable than these.

The mortality after ovariotomy appears to be increased by the existence of adhesions. When these complicated the operation, in those cases in which the ovarian tumor was completely removed, 49 per cent. of the cases died; when they did not exist, 32 per cent. were fatal.

When we compare these returns, not only with the mortality which follows operations of immediate urgency—as primary amputation of the thigh for injury—but with that which attends great operations for diseases that might be palliated and in which existence might be protracted for some little time—as amputation at the hip-joint for tumor, or the ligature of the innominate and subclavian arteries for aneurism, or even that for the extraction of vesical calculus of large size by lithotomy in the adult—we cannot consider the mortality after ovariotomy so great as to interfere with the performance of the operation, if other circumstances justify it.

It has further been objected to ovariotomy, that it has not unfrequently happened that, after the operation has been commenced, it has been found impossible to complete it, owing to the existence of adhesions between the tumor and the contents of the abdomen. This objection is certainly a grave one; but I believe that, with care in examining the tumor, and ascertaining its mobility during respiration, the existence or absence of crackling under the abdominal wall during the respiratory movements, the freedom from connection with the uterus, as determined by finding that organ floating on the introduction of the uterine sound, and the previous non-occurrence of peritonitis, this mistake is not now so likely to happen as formerly, when the liability to it was not suspected.

[Another very grave objection to ovariotomy is the occasional difficulty, in some cases amounting to impossibility, of making a positive diagnosis. Thus even Spencer Wells has mistaken a cystic kidney for an ovarian tumor, an attempt at extirpation proving fatal in thirty hours. (*Dublin Quarterly Journal of Medical Science*, February, 1867, page 134.)—A.]

Operation.—On the day preceding the operation, a dose of castor oil should be administered, and on the morning of it an enema, so that the bowels may be completely emptied. The room having been raised to a temperature of at least 70° F., chloroform administered, and the bladder emptied by the catheter, the patient must be placed upon a table covered with blankets, in such a way that the legs hang over the end of it, and the abdomen is fairly and evenly exposed. The surgeon, taking his stand between the patient's legs, makes an incision, usually about four inches in length, from the umbilicus downwards, directly in the mesial line; by a few touches of the knife, the structures, which are usually much thinned, are divided along the linea alba, and the abdominal cavity is opened.

There has been much discussion as to the length to which the incision in the abdominal wall should be made; some practitioners recommending that this should be of very limited extent, others that it should reach from the ensiform cartilage to the pubes. No definite rule can be laid down upon this point. The incision must be proportioned in extent to the size and nature of the tumor, and the existence or absence of adhesions. If the tumor be cystic and unilocular, and not adherent, it may be readily enough extracted by making an incision only an inch or two in length in the mid-line, tapping it through this, and then drawing the emptied cysts forwards by means of a vulsellum. If, on the other hand, the ovarian growth be chiefly solid, a larger incision, from four to six inches in extent, will be required. Should adhesions exist, it may even be necessary to go beyond this; though I cannot believe that it is ever necessary to rip up the abdomen from the sternum to the pubes, for the removal of any tumor, however large or adherent. In making this incision, the surgeon must be careful to open the peritoneum fairly, and not to mistake it for the cyst-wall, and so strip it off the abdominal muscles.

The tumor now comes into view; if cystic, it must be tapped with a large and long trocar, and the fluid evacuated. Especial care should be taken not to allow this viscid ovarian fluid to escape into and flood the abdominal and pelvic cavities. This may often be avoided by conducting it away from the patient, by means of a

nal wall without further difficulty. If it be solid, or if there be any adhesions, the surgeon must introduce his hand, and by sweeping it round the tumor assist in removing the mass. The chief difficulty in the operation will consist in the presence of adhesions. Should none exist, nothing can be simpler than the extraction of the tumor, which has a tendency to protrude forwards into the wound. Should they be slight and confined to its anterior part, attaching this to the abdominal wall, they may readily enough be broken through by the hand being swept round the forepart of the tumor. If they be firm, deep, and extensive, then the real difficulty of the operation will have to be encountered. It is, however, important to observe that adhesions of this kind will chiefly be found at the anterior part, between the tumor and the abdominal wall; comparatively seldom posteriorly, or connected with any of the abdominal viscera, except the uterus. If possible, these adhesions should not be cut across, as they often contain vessels that would bleed freely if so divided; but they should rather be torn—no slight force occasionally being required to detach them. Should the tumor be so closely adherent to any viscus that its separation is attended with danger, it might be safer to cut across the cyst-wall, and leave the adherent portion of this, than to run the risk of laceration of the liver or intestine. During the withdrawal or protrusion of the mass from the abdomen, an assistant on each side must press gently upon the sides of the incision with the hands or with soft napkins, so as to prevent the protrusion of the intestines, which, if possible, should not be seen during the operation. The tendency to intestinal protrusion sometimes occasions considerable trouble; especially if the patient have taken chloroform and begin to vomit, when it may be necessary to discontinue the operation for a time.

The separation of the pedicle is the next step, and perhaps the most important one in the operation. In order to do this securely, some surgeons fix the pedicle by means of a clamp, and then cut it across above this instrument, searing the cut surface with the actual cautery. To this there can be no objection, if the pedicle be long and narrow; but if it be short and thick, great inconvenience may result by the clamp either being drawn down into the pelvic cavity, or the pedicle and pelvic organs being drawn upwards to a painful and perhaps dangerous extent. In such cases, it is better to tie it with a whipcord ligature. This may best be done by drawing the tumor well forwards, transfixing the pedicle with a nævus-needle carrying a strong whipcord ligature, tying this firmly on each side, and then cutting it across above the constricted portion. In doing all this, a few points require attention. Care should be taken that the needle do not transfix any large artery or vein. This may generally be avoided by spreading out or unravelling, as it were, the pedicle, and examining its structure before passing the ligature. After it has been transfixed, and before the cord is tied, it is well to dissect off that portion of the peritoneal investment of the pedicle which corresponds to the line that will be constricted by the ligature. In doing this, great care must, however, be taken not to wound the vessels, especially the veins, which are very thin-walled. In this way there will be less risk of peritonitis, as there is less chance of any slough of the pedicle falling into the peritoneum.

After its ligature, the pedicle should be divided about half an inch above the part tied. If it be cut across nearer the ligature, there will be danger of the stump retracting under it, and of secondary hemorrhage, which has caused 16 per cent. of the deaths after this operation.

The next point in connection with the pedicle is fixing it properly *out* of the peritoneal cavity, so that it may not return into this, as it always has a tendency to do, and thus excite undue inflammation by the presence of the ligatures and resulting slough in the serous membrane. I look upon this fixing of the pedicle well out of the peritoneal cavity as one of the most important steps of the operation, on which the patient's safety more immediately depends than any other. The most convenient way to fix it is to close the lower part of the incision in the abdominal wall by a hare-lip pin passed across it, about half an inch above its angle, and, drawing the stump of the pedicle well out of the abdomen through this, to retain it there by twisting the whipcord ligature with which it has been tied, in the usual figure-of-8 manner, round the pin; in this way it cannot possibly be

peritoneal cavity.

The incision in the abdomen may be closed either by continuous sutures passed from within outwards, or by a series of *silver pins* passed across from one lip to the other, at intervals of about an inch from each other. These pins should be passed deeply, not only through the whole thickness of the integuments and muscles, but also through the peritoneum. Figure-of-8 sutures are passed round these in the usual way, and then crossed from pin to pin. In this way the whole line of incisions is firmly and accurately supported. The abdominal wall must be still further supported by broad and long slips of plaster, and a laced napkin round the body.

Should it unfortunately be found, during the progress of the operation, that adhesions exist, so close and extensive as to prevent the removal of the tumor, the wound in the abdominal wall must be closed, and the same after-treatment adopted as in the successfully completed operation.

The *after-treatment* of the case will require the most careful attention, although it presents nothing of a very special character, or that differs from the management of ordinary abdominal operations. The dangers to be apprehended are from peritonitis, exhaustion, and secondary hemorrhage. Peritonitis requires to be more carefully guarded against than perhaps any other complication: of 150 fatal cases, it was the cause of death in 64, or 42 per cent. The patient should be kept in bed, in a uniform temperature. Nothing but ice and barley- or Seltzer-water, brandy, and beef-tea should be allowed for several days; and opium, especially the "blackdrop," must be given in sufficient and repeated doses, to keep the system slightly influenced by it. The urine must be drawn off thrice in the twenty-four hours; but the bowels should be left unrelieved for at least ten or twelve days, and then merely opened by an enema. As no solid food should be given during the whole of this time, little inconvenience results. If peritonitis come on, it must be treated in accordance with the rules laid down when speaking of strangulated hernia. Should symptoms of exhaustion manifest themselves, the patient must be kept up by wine or brandy, repeated as frequently as the irritable state of the stomach will permit.

After recovery from ovariotomy, the cure is usually complete. Impregnation may occur through the medium of the ovary that is left; and parturition may be safely accomplished. In some rare instances, however, the ultimate result is not so fortunate. If the tumor have been malignant, recurrence may take place; and occasionally the ovary that is left becomes the seat of disease, so as to necessitate a second operation.

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